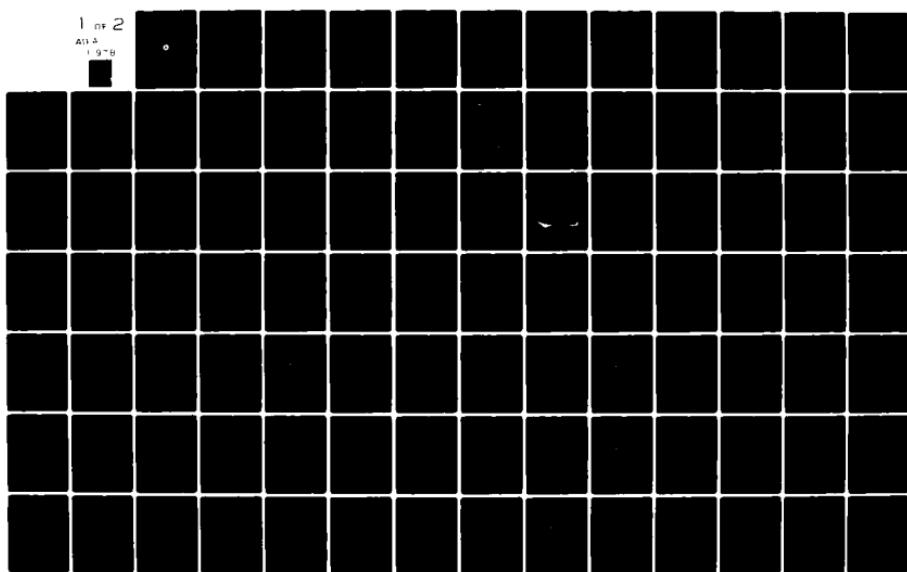
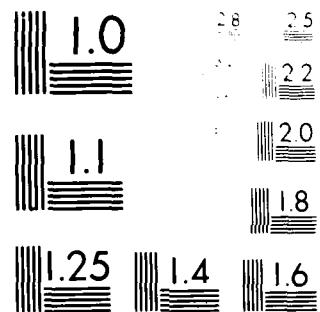


AD-A111 978 ECLECTECH ASSOCIATES INC NORTH STONINGTON CT F/6 17/7
AT-SEA DATA COLLECTION FOR THE VALIDATION OF PILOTING SIMULATIO--ETC(U)
DEC 81 R B COOPER, R C COOK, K L MARINO DOT-CG-835285-A
UNCLASSIFIED EA-81-U-078 USCG-D-60-81 NL

1 of 2

ATA
1978





McGraw-Hill Resolution Test Chart

(12)

CG-D-60-81

ADA111978

AT-SEA DATA COLLECTION FOR THE
VALIDATION OF PILOTING SIMULATION

Eclectech Associates, Inc.
North Stonington Professional Center
North Stonington, Connecticut 06359



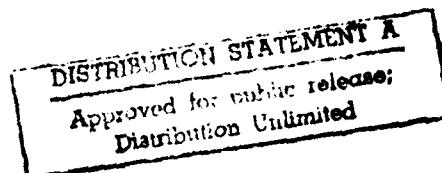
December 1981

Interim Report

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
United States Coast Guard
Office of Research and Development
Washington, D.C. 20590

DTIC
ELECTE
S MAR 12 1982
D
H



82 66 1 100

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

Technical Report Documentation Page

1. Report No. CG-D-60-81	2. Government Accession No. AD-141195	3. Recipient's Catalog No.	
4. Title and Subtitle At-Sea Data Collection for the Validation of Piloting Simulation.		5. Report Date December 1981	
7. Author(s) R.B.Cooper, R.C. Cook & K.L. Marino		6. Performing Organization Code	
9. Performing Organization Name and Address Eclectech Associates, Inc. North Stonington Professional Center North Stonington, Connecticut		8. Performing Organization Report No. EA-81-U-078	
12. Sponsoring Agency Name and Address Department of Transportation U.S. Coast Guard Office Research and Development Washington, D.C. 20590		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. DOT-CG-835285-A	
		13. Type of Report and Period Covered Interim Report	
		14. Sponsoring Agency Code G-DST-1	
15. Supplementary Notes None			
16. Abstract The report describes a U.S. Coast Guard project to track piloted commercial vessels for the purpose of developing simulator validation criteria. The recording of precise ship's position was conducted on the upper Chesapeake Bay using the Raydist tracking system. At the same time all pilot activities were recorded and correlated with ship position. Variables included whether or not traffic was present, direction of travel in the waterway, ship design and response characteristics, and environmental conditions. The effects of these variables in shiphandling performance are presented as statistical plots of the ship tracks. Data will be used for validating the U.S. Coast Guard ship simulator at Eclectech Associates, and more specifically the results of all aids to navigation research conducted on this simulator.			
17. Key Words (for this report) simulator validation, piloting simulation, ship simulation, ship tracking, at-sea data collection, pilot performance, aids to navigation, pilotage, Raydist	18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, VA 22161		
19. Security Classif (for this report) UNCLASSIFIED	20. Security Classif (for this page) UNCLASSIFIED	21. No. of Pages 153	22. Price

BLANK PAGE

ACKNOWLEDGEMENTS

The authors, on behalf of the U.S. Coast Guard, wish to express their sincere appreciation to the Association of Maryland Pilots and in particular Captain George A. Quick, President, without whose close support and involvement in this project it could not have been accomplished. From the office staff, dispatchers, auto drivers, and launch captains to the pilots, themselves, all went out of their way to accommodate our unusual requests and make us feel very welcomed. We thank you! We are also indebted to the many masters who permitted us aboard their ships for the brief voyage through Baltimore Harbor, and the special hospitality shown by their crew members.

Finally, those of us on the "tracking team" would like to thank Captain J.T. Montonye, USCG, for his close support in the project; and QM1 Bruce McIntosh who performed as the RAYDIST equipment operator. Quartermaster McIntosh accepted enormous responsibility during this experiment, both in coordinating activites with the pilot office, and in ensuring installation, checkout, and operation of the portable tracking equipment carried aboard each ship. As evident in this report, the collection of experimental data at sea requires extensive logistical support and cooperation among all personnel involved. The success of this particular study must, therefore, be attributed to the keen interest and special dedication of all its participants. Again, our thanks!

3
C
INSPR

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC T&B	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
1000	1000
Dist	Special
A	

PREFACE

This experiment was conducted as part of an ongoing program by the U.S. Coast Guard to determine the effectiveness of various fixed, floating, and electronic aids to navigation for harbor pilotage. Along with a number of experiments conducted in ship's bridge simulators, two evaluations of the aids to navigation were conducted at sea. This report describes the first of the at-sea experiments, both which were performed on the upper Chesapeake Bay as "experiments of opportunity."

In the fall of 1980 worldwide demand for coal had produced a queuing of as many as 40 coal ships in the Annapolis anchorage awaiting entrance to the Baltimore coal docks. Since inbound transits of these ships occurred at approximately once every 24 hours, an ideal opportunity arose for tracking a large number of ships within a relatively short period of time. This enabled the compilation of a statistically supportable data base for use in the validation of ship's bridge simulators. As an additional benefit, this course of events provided opportunities for tracking a variety of different ships, using pilots with whom excellent rapport had been established, and through a waterway in which accuracy of the automatic tracking equipment was verifiable. The result was an experiment and compilation of tracking data on 21 ships within a period of 1 month. The data was then categorized and analyzed by condition, and is presented in this report. This data will be used for validating the ship's bridge simulator built for the U.S. Coast Guard at Eclectech Associates and which was used in conducting most of the other experiments in the aids to navigation program.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol	When You Know	Multiply by	To Find	Symbol	When You Know	Multiply by	To Find
LENGTH											
inches feet yards miles											
12 3 3 5.6											
inches	12	1.05	centimeters	mm	mm	0.04	inches	in	in	in	in
feet	30	30	centimeters	cm	cm	0.4	inches	in	in	in	in
yards	6.9	6.9	meters	m	m	3.3	feet	ft	ft	ft	ft
miles	1.6	1.6	kilometers	km	km	1.1	yards	yd	yd	yd	yd
AREA											
square inches square feet square yards square miles acres											
144 144 144 2.59 43,560											
square inches	144	1.00	square centimeters	cm ²	cm ²	0.16	square inches	in ²	in ²	in ²	in ²
square feet	144	144	square meters	m ²	m ²	1.2	square yards	yd ²	yd ²	yd ²	yd ²
square yards	144	144	square meters	m ²	m ²	0.4	square miles	mi ²	mi ²	mi ²	mi ²
square miles	2.59	2.59	square kilometers	km ²	km ²	2.5	acres	acres	acres	acres	acres
acres	43,560	1.00	hectares	ha	ha	1.1	hectares	ha	ha	ha	ha
MASS (weight)											
ounces pounds short tons (2000 lb)											
28 0.45 0.9											
ounces	28	1.00	grams	g	g	0.035	ounces	oz	oz	oz	oz
pounds	0.45	0.45	kilograms	kg	kg	2.2	pounds	lb	lb	lb	lb
short tons	0.9	0.9	tonnes	t	t	1.1	short tons	t	t	t	t
(2000 lb)	2000	1.00	tonnes	t	t	1.1	tonnes	t	t	t	t
VOLUME											
teaspoons tablespoons fluid ounces cups											
5 15 30 0.24											
teaspoons	5	1.00	milliliters	ml	ml	0.03	fluid ounces	fl oz	fl oz	fl oz	fl oz
tablespoons	15	15	milliliters	ml	ml	2.1	pints	pt	pt	pt	pt
fluid ounces	30	30	milliliters	ml	ml	1.06	quarts	qt	qt	qt	qt
cups	0.24	0.24	liters	l	l	0.26	gallons	gal	gal	gal	gal
pints quarts gallons											
0.47 0.95 3.8											
pints	0.47	1.00	liters	l	l	35	cubic feet	ft ³	ft ³	ft ³	ft ³
quarts	0.95	0.95	liters	l	l	1.3	cubic meters	m ³	m ³	m ³	m ³
gallons	3.8	3.8	cubic meters	m ³	m ³	1.1	cubic yards	yd ³	yd ³	yd ³	yd ³
TEMPERATURE (exact)											
°Fahrenheit temperature											
5/9 other temperature subtracting 32)											
°Fahrenheit	5/9 other	subtracting	32)	°Celsius	°Celsius	°C	°Celsius	°C	°Fahrenheit	°Fahrenheit	°Fahrenheit
temperature	temperature	temperature	temperature	temperature	temperature	°C	temperature	°C	temperature	°Fahrenheit	°Fahrenheit
TEMPERATURE (exact)											
°Celsius temperature											
°C											
°C	5/9 other	subtracting	32)	°C	°C	°C	°C	°C	°Fahrenheit	°Fahrenheit	°Fahrenheit
temperature	temperature	temperature	temperature	temperature	temperature	°C	temperature	°C	temperature	°Fahrenheit	°Fahrenheit

1 in = 2.54 centimeters. For further exact conversions and more detailed tables, see NBS Spec. Pub. 266.

Units of Weight and Measures, Price 25. SD Catalog No. C131026.

1 in = 2.54 centimeters. For further exact conversions and more detailed tables, see NBS Spec. Pub. 266.

Units of Weight and Measures, Price 25. SD Catalog No. C131026.

BLANK PAGE

VL

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>	<u>Page</u>
1	INTRODUCTION	1
	1.1 Overview of the Aids to Navigation Program	1
	1.2 Requirements for Simulator Validation	3
	1.3 Limitations of the Data Collection	4
2	METHODOLOGY	7
	2.1 Experimental Design and Variables	7
	2.2 Data Collection and Analysis	9
3	RESULTS AND CONCLUSIONS	15
	3.1 The Effect of Variables on Shiphandling	15
	3.2 Utilization of Data in Simulator Validation	34
	BIBLIOGRAPHY	37
<u>Appendix</u>		
A	INDIVIDUAL RUN DATA	A-1
B	OBSERVER'S DATA COLLECTION BOOKLET	B-1

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1	Upper Chesapeake Bay Where At-Sea Data was Collected	10
2	Data Computation Points	13
3	Effect of Traffic on Performance, Leg 1	16
4	Effect of Traffic on Performance, Leg 2	17
5	Effect of Direction on Performance, With Traffic	20
6	Effect of Direction on Performance, With No Traffic	21
7	Effect of Ship Length on Performance, Leg 1	24
8	Effect of Ship Length on Performance, Leg 2	25
9	Effect of Ship Beam on Performance, Leg 1	26
10	Effect of Ship Beam on Performance, Leg 2	27
11	Effect of Wind Speed on Performance, Leg 1	30
12	Effect of Wind Speed on Performance, Leg 2	31
13	Effect of Tidal Current on Performance, Leg 1	32
14	Effect of Tidal Current on Performance, Leg 2	33

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
1	At-Sea Data Collection Variables	8

Section 1
INTRODUCTION

1.1 AN OVERVIEW OF THE AIDS TO NAVIGATION PROJECT

The United States Coast Guard is responsible for safety in U.S. harbors and channels and, therefore, for the aids to navigation (AN) necessary to ensure that safety. It is in fulfillment of this responsibility that the Coast Guard is sponsoring a simulator-based program of research into the performance of these aids to navigation. Interests include visual aids to navigation, radar navigation, and electronic radio aids to navigation. To reduce the overall evaluation to a workable size, the first experiments were restricted to buoys and electronic radio aids to navigation systems. Future plans are to expand the evaluation to ranges and leading lights, and to radar. The objectives of the project are the use of experimental data to derive design criteria for the placement of aids to navigation and to specify radio aids to navigation systems for restricted waterways navigation. Specifically, the program will produce an "AN Design Manual" for use by various offices of the Coast Guard. It will (1) establish maintenance priorities for short-range aids to navigation, (2) determine the minimum design configurations of these aids under a variety of implementation conditions, and (3) quantify the relative risk to navigation as a function of the AN configurations.

Components of the project completed to date are available as separate reports. The first of these was an analysis of the variables expected to affect visual piloting.¹ To enhance the applicability of the findings to real-world harbors, major U.S. ports were surveyed from charts, cataloging the conditions that presently exist.² Four experiments on visual piloting with floating aids have been completed.

¹W.R. Bertsche and R.C. Cook. "Analysis of Visual Navigational Variables and Interactions." U.S. Coast Guard, Washington, D.C., October 1979.

²W.R. Bertsche and R.T. Mercer. "Aids to Navigation Configurations and the Physical Characteristics of Waterways in 32 Major U.S. Port." U.S. Coast Guard, Washington, D.C., October 1979.

These are the "CAORF,"³ "Channel Width,"⁴ "Ship Variables,"⁵ and "One Side Channel Markings"⁶ experiments. Related studies on pilotage using electronic radio aids to navigation displays were also performed.^{7,8,9}

The first simulator experiment on floating aids to navigation was conducted on the U.S. Maritime Administration's Computer Aided Operations Research Facility (CAORF) located at Kings Point, New York. This simulator had been in use for more than 5 years and had been validated primarily in open sea conditions for collision avoidance experiments. The simulation of restricted waterways and harbor pilotage had not yet received a full validation with real-world conditions. Nevertheless, results of the early AN experiments were deemed appropriate for extrapolation to real-world performance. All subsequent experiments were conducted on a ship's simulator built for the U.S. Coast Guard and located at Eclectech Associates, Incorporated, North Stonington, Connecticut. Both simulators provide a fully equipped ships bridge with visual scene, and are computer controlled to replicate high fidelity ship systems, ship hydrodynamics, and environmental effects.

³M.W. Smith and W.R. Bertsche. "Aids to Navigation Report on the CAORF Experiment. The Performance of Visual Aids to Navigation as Evaluated by Simulation." U.S. Coast Guard, Washington, D.C., August 1980.

⁴M.W. Smith and W.R. Bertsche. "Aids to Navigation Principal Findings Report on the Channel Width Experiment: The Effects of Channel Width and Related Variables on Piloting Performance." U.S. Coast Guard, Washington, D.C., January 1981.

⁵W.R. Bertsche, D.A. Atkins, and M.W. Smith. "Aids to Navigation Principal Findings Report on the Ship Variables Experiment: The Effect of Ship Characteristics and Related Variables on Piloting Performance." U.S. Coast Guard, Washington, D.C., April 1981.

⁶K.L. Marino, M.W. Smith, and W.R. Bertsche. "Aids to Navigation Principal Findings Report: The Effect of One-Side Channel Marking and Related Conditions on Piloting Performance." U.S. Coast Guard, Washington, D.C., July 1981.

⁷R.B. Cooper and K.L. Marino. "Simulator Evaluation of Electronic Radio Aids to Navigation Displays - The Miniexperiment." U.S. Coast Guard, Washington, D.C., September 1980.

⁸R.B. Cooper, K.L. Marino, and W.R. Bertsche. "Simulation Evaluation of Electronic Radio Aids to Navigation Displays, The RA-1 Experiment." U.S. Coast Guard, Washington, D.C., January 1981.

⁹R.B. Cooper, K.L. Marino, and W.R. Bertsche. "Simulation Evaluation of Electronic Radio Aids to Navigation Displays, The RA-2 Experiment." U.S. Coast Guard, Washington, D.C., April 1981.

A detailed description and comparison between these simulators is presented in Channel Width¹⁰ and Ship Variables¹¹ reports. While the studies cited were not originally intended to compare the simulators, certain parameters which were measured readily lent themselves to just such a comparison. The studies specifically addressed those aspects of simulation that are expected to affect pilotage performance; ship hydrodynamics, environmental effects, and visual effects. From a comparison of data between the two simulators, minor differences were found in some aspects of the environmental effects data base. Performance differences among conditions represented by identical scenarios were the same within each simulator. This led to the conclusion that the two simulators are similar in their usefulness for the exploration of relationships between aids to navigation and piloting performance. While the research addressed compatibility between CAORF and the USCG/EA simulator, a requirement to validate the USCG/EA simulator with real-world conditions persisted. Such an endeavor has been initiated by collecting and compiling the at-sea data which is presented in this report.

1.2 REQUIREMENTS FOR SIMULATOR VALIDATION

Since its conception, the philosophy of the AN program has been that the relationships between aids to navigation characteristics and resulting piloting performance is so complex that it must be studied in isolated parts. This requirement necessitated a high degree of experimental control, with the assurances that results of the experiments would be directly applicable to the real world. It was concluded that high fidelity, real-time simulation could fulfill both of these requirements better than the real-world environment itself. While the real-world does contain all relationships of interest, the impossibility of satisfactorily isolating and controlling its many variables makes simulation much more attractive. Through simulation, it is possible to select any condition, investigate the effects of as many variables as required, and recreate identical circumstances for needed repetition. All of these characteristics were necessary to adequately investigate the relationships of aids to navigation and channel design on piloting performance.

In using simulator-based research to derive design criteria for the placement and use of aids to navigation, the results must reflect those which would occur in the real world. A fundamental requirement of all simulator research is validation of the simulator and subsequently its results. To achieve this in the AN program it was decided to thoroughly analyze and document real world piloting performance; and to compare such performance with similar aids to navigation variables, ship types, channel designs, and environmental conditions. The quality of this comparison would represent validity both of the simulator and its results providing there were adequate assurances that the simulation did, in fact, cause the performance effect.

¹⁰M.W. Smith and W.R. Bertsche, op. cit., January 1981.

¹¹W.R. Bertsche, D.A. Atkins, and M.W. Smith, op. cit.

1.2.1 Special Considerations

To validate the USCG/EA simulator, at-sea data on ship tracks and shiphandling performance of pilots in restricted waterways were required. From this, validation criteria were derived to test both comparability and transferability between the simulated and real-world runs. The derivation of these criteria are as follows:

a. Channel Design. The Craighill Channel and Craighill Channel Upper Range in the upper Chesapeake Bay were selected as sites for the collection of at-sea data for simulator validation. This selection was based upon channel size, angle of bends, and buoyage similar to those scenarios which appeared in the AN program simulations. While the at-sea and simulated waterways were not completely identical, the establishment of common goals (e.g., to keep on the channel centerline) and common measures (e.g., crosstrack distance) enabled comparisons of the pilotage performance.

b. Logistics Requirements. The fulfillment of adequate repetitions to accommodate a statistical analysis was possible due to the high frequency of vessel transits, relatively short duration of these transits, and ease of accessibility provided by the Association of Maryland Pilots. The accessibility enabled trained observers to accompany the pilots aboard each ship, thus replicating the observation capability of most simulators. This accessibility also permitted carrying aboard and installation of precision tracking equipment for the accurate recording of ship response data. In the simulator, these data are retained in computer memory. Logistics of the at-sea data collection were very favorable by traditional standards. Over 90 percent of the data was usable; and even though the operation was considered to be less cost effective than simulation per se, it was conducted on a most opportune occasion and in a timely fashion.

c. Ship Type and Hydrodynamics. Criteria for the validation of ship response characteristics were achieved by examining as many single type ships (i.e., coal carriers) as possible; but also including others when the opportunity arose. There was, of course, large variety in overall design characteristics even among the single type ships. Ship Variables¹² report, which addresses the effects of ship design and response characteristics on piloting performance, suggests that validation could be achieved between the real word and simulation even without replicating identical vessels. For this reason, all particulars of each ship transited were recorded (see Appendix A), and results of the at-sea analysis are categorized by those which did influence piloting performance.

1.3 LIMITATIONS OF THE DATA COLLECTION

Difficulties encountered as a result of real-world data collection are traditionally the limiting factor in validation. Events which occurred in the derivation and processing of at-sea data support this

¹²Ibid.

conclusion. Two types of difficulties were encountered, both of which could have had a major impact on the quality of data; but which have been overcome either by voiding the data or by acknowledging it for "what it is worth."

The first problem encountered was that although pilots were requested to stay as close to the channel centerline as possible, traffic in the waterway often required ownship to maneuver. Through radio communications with their colleagues, all pilots did their best to arrange passings which allowed ownship to remain on the centerline. To the extent that the other pilots accommodated and that environmental conditions permitted, the researchers are very grateful. Nevertheless, there were a total of 12 transits out of the 21 in which traffic affected ownship in at least one of the two legs of the waterway. Considering the analysis could be broken down into individual legs, this meant there were 30 out of a possible 41 transits of legs in which ownship did not maneuver for traffic and could have remained on the channel centerline. This provided sufficient data for reporting valid runs without traffic as well as runs which included maneuvering for traffic. The reader is reminded, however, that in runs with traffic, the pilot of the traffic ship was probably aware of ownship's desire to remain on the centerline. Subsequently, ownship may have been given an extra wide berth and responded with a smaller than normal maneuver. Particulars of the passing or overtaking such as distance abeam, relative speed, traffic ship description, etc., were not recorded in detail since no validation of traffic simulation was anticipated. All other data on these runs, however, have been compiled and are presented in the report.

The second problem encountered in the at-sea data collection was symptomatic of real-world measurement in general: system failure. Owing primarily to alignment requirements of the automatic tracking system, limitations in operator capability contributed as much to these problems as did hardware malfunction. Specifically, alignment of the tracking equipment required that it be initialized on specially constructed visual ranges. On two occasions these ranges were obscured voiding all tracking data for the run. In two other runs ships' electric power was either not compatible with the tracking system or was unreliable. This problem was resolved for the remainder of the experiment by carrying a power conversion unit aboard each ship with the tracking equipment. Of the remaining 17 transits, no tracking data was available on three due to printer malfunction or the unexplained loss of tracking on one line of position (LOP). The result was that 14 of the 21 runs were conducted with good tracking data and only this data is included in the analysis of piloting performance.

Required information regarding each ship's design and performance was readily available on its bridge. A full report of observed data was also produced during each run. All this data is presented in Appendix A.

(THIS PAGE INTENTIONALLY LEFT BLANK)

Section 2

METHODOLOGY

The methodology employed in this experiment was passive in nature. Simply stated, pilots were instructed to remain on or as close to the channel centerline as possible, and their ship was tracked to determine how well they achieved this goal. There were, of course, extenuating circumstances with traffic, ship equipment, and ship personnel; as well as environmental factors, which affected pilots' performance. Data describing these circumstances were recorded manually to explain either why the goal might not have been achieved, or for inclusion in any simulator replication for validation purposes.

2.1 EXPERIMENTAL DESIGN AND VARIABLES

An experimental design was developed to accommodate uncontrollable pilot assignments to ships, the relative lack of control over ship characteristics and environment; yet the need to fulfill certain requirements of the data collection. Although pilots are assigned by rotation, there was no way to plan each individual's involvement. As a result, "subject selection" was considered to be random and "individual differences" were considered to be negligible. There were no repetitions of runs with the same pilot. To the extent practical, at least one observer in the tracking team had participated in most of the other runs. This ensured consistency in manual data collection, while the aligned system ensured repeatability.

The first consideration for simulator validation criteria was perceptual (i.e., ship appearance and equipment) and hydrodynamic (i.e., handling) characteristics. All inbound ships were in ballast. Since their drafts and propulsion characteristics varied relatively proportional to their size, they were categorized by ship length and beam width. Environmental conditions which affect the pilotage were recorded during each run. The data sheets listing these conditions are presented in Appendix A. The major differences noted in environmental conditions were wind speed and direction of tidal current. Wind direction and current speed, while it may have had some effect on individual runs, was too varied to obtain a statistical sample.

As discussed in Section 1.3 the absence or presence of traffic also produced significant effects on pilotage. Table I shows each run by number and variable. The compilation and review of data on these runs produced the subsequent categorization of variables for analysis:

<u>Variable</u>	<u>Level</u>
Traffic	Runs with traffic
	Runs with no traffic
Direction	Outbound runs with traffic
	Inbound runs with traffic
	Outbound runs with no traffic
	Inbound runs with no traffic

TABLE 1. AT-SEA DATA COLLECTION VARIABLES

RUN#	DATE	TRAFFIC		DIRECTION		SIZE (000 dwt)	LENGTH (feet)	BEAM (feet)	WIND SPEED	WIND DIRECTION	CURRENT	DRAFT	HEIGHT OF EYE
		1980	Leg 1	Leg 2	Travel								
1	10/20	Y	Y	In	Day	USCG	.5	157	31	5	NW	NA	6'7"
2	10/21	N	Y	In	Night	BULK	130	810	133	5	SW	EBB	34'
3	10/22	N	Y	Out	Day	BULK	62	705	106	5	S	FLOOD	21'6"
4	10/27	N	N	In	Day	BULK	50	657	95	5	SE	FLOOD	21'
5	10/28	N	N	In	Day	BULK	79	775	105	15	NE	FLOOD	23'
6	10/30	Y	N	Out	Day	BULK	35	586	88	5	NW	FLOOD	10'
7	11/10	N	N	In	Day	BULK	63	698	105	15	NW	SLACK	20'
8	11/13	N	Y	In	Day	TANK	31	565	85	5	W	FLOOD	32'
9	11/19	Y	N	In	Night	BULK	51	646	105	5	W	SLACK	29'
10	11/20	Y	N	In	Day	BULK	30	793	106	5	NW	EBB	23'
11	12/3	Y	N	In	Night	CONT	16	610	78	20	NW	SLACK	26'
12	12/5	N	N	In	Day	BULK	70	800	105	5	NW	FLOOD	24'
13	12/8	N	N	In	Day	BULK	69	786	106	5	S	EBB	29'
14	12/8	Y	N	In	Night	BULK	116	823	133	15	S	FLOOD	26'
15	12/10	N	Y	In	Day	BULK	44	680	90	15	NW	FLOOD	21'
16	12/10	Y	N	Out	Day	BULK	44	680	90	15	NW	SLACK	21'
17	12/11	N	N	In	Day	TANK	32	530	85	0	NE	EBB	33'
18	12/12	N	Y	In	Day	BULK	60	744	104	15	S	EBB	23'
19	12/16	N	N	In	Day	BULK	62	705	106	5	NW	FLOOD	22'
20	12/17	N	N	In	Day	BULK	18	481	67	15	NW	EBB	24'
21	1/1	N	N	In	Day	USCG	.5	157	31	25	NW	NA	6.5'

Ship characteristics	Ship length under 650 feet Ship length over 650 feet
	Ship beam under 90 feet Ship beam over 90 feet
Environment	Wind speed under 10 knots Wind speed over 10 knots
	Ebb tidal current Flood tidal current Slack tidal current

The comparison of piloting as a function of these variables is presented in Section 3.

2.2 DATA COLLECTION AND ANALYSIS

Figure 1 shows the chart segment of the waterway in which the at-sea data was collected. Data collection started when outbound abeam buoy "4B" in the Brewerton Channel, and when inbound at the entrance to Craighill Channel. The tracking equipment was aligned using two separate ranges on Sandy Point. These ranges were situated to correspond with known lines of position (LOPs). A lane correction factor could be added or subtracted to achieve the daily correction. As shown on the plots of Section 3, pilots normally departed from the centerline in the cutoff bend between buoys "9C" and "15C." Data within this area are not compared in the analysis and should be excluded from any validation criteria.

The following basic data are needed for simulator validation and have been accommodated in the at-sea experiment. They are divided into three categories: navigation scenario, vessel position, and pilot task and command data. A copy of the observer's data collection booklet which was carried aboard to record much of this data is presented in Appendix B.

2.2.1 Navigation Scenario

a. Vessel type. Available commercial vessels were used. They included bulk carriers (coal and sugar), container vessels and tankers. Vessel characteristics including dimensions, draft, propulsion, and maneuvering data were recorded.

b. Navigator type. Only pilots from the Maryland Association of Pilots participated.

c. Availability of shipboard navigation instruments. The onboard suite of bridge equipment and navigation instruments was documented.

d. Availability of aids to navigation. Aids to navigation in Craighill Channel and Craighill Channel Upper Range were assumed to be those shown on the most current chart available and documented in the Light List (1980). Any changes to the above configuration both reported (Local Notice to Mariners) or unreported were noted for each transit.

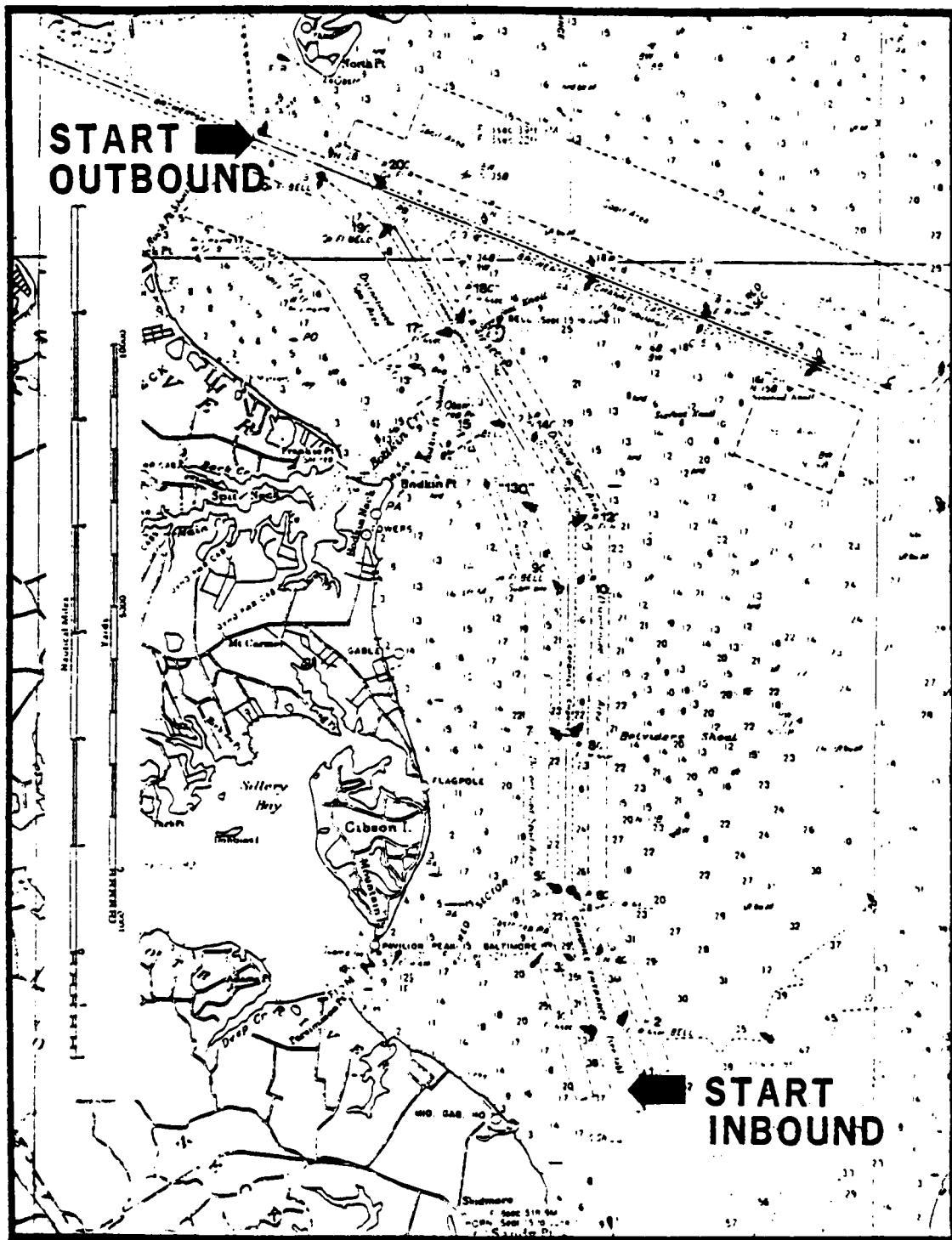


Figure 1. Upper Chesapeake Bay Where At-Sea Data was Collected

e. Visibility. The visibility range for each transit was expressed and documented as the range (in nautical miles) at which buoys of comparable size to those in Craighill Channel were first sighted. The criteria was applied for both inbound and outbound transits. It was also applied under both daylight and nighttime conditions. Any precipitation was noted.

f. Direction of travel. The direction of travel, inbound or outbound, was documented for each transit.

g. Traffic. The presence of traffic was documented for each transit. The size of the traffic ships, the time of first maneuver to adjust for traffic, and time of passing abeam was noted.

h. Time of day. The zone time at each event and at various geographical locations was recorded (e.g., abeam Sandy Point light, abeam Seven Foot Knoll, etc.).

i. Water depth. Water depth was determined from (h.) and the Tide Tables (1980) after each transit.

j. Current. Current was determined from (h.), the Tidal Current Tables and the Tidal Current Charts (1973) after each transit. Comments from the pilot concerning current were also recorded.

k. Wind. The true wind velocity and direction in the waterway were either measured or estimated prior to getting underway at the anchorage. Comments from the pilot which concerned the effects of wind during the transit were also recorded.

2.2.2 Vessel Position Data

a. The tracking equipment, specifically the DRS-H RAYDIST radio location system was leased by the Coast Guard Office of Navigation for the project. The equipment which consisted of an antenna, receiver, power supply, and strip chart recorder were carried aboard each ship, assembled, and operated. Instructions for initializing and calibrating the system for each transit are provided in Appendix B.

b. Vessel position was printed every 10 seconds on the strip chart along with clock time. Since all observed data were recorded with a time line, it was possible to reconstruct ownship's position at each observed and recorded event. Additionally, the strip chart was annotated by the RAYDIST operator at certain preselected points along the waterway, just to verify tracker operation.

Repeatable positioning accuracy of the RAYDIST system used is ± 0.02 lanes (approximately ± 1 meter) within the operational range of the system.¹³ Total geographic accuracy is 2 meters RMS providing initialization alignment is within specification.

¹³ C.E. Hastings and A.L. Comstock. "Pinpoint Positioning of Surface Vessels Beyond Line-of-Sight." A paper presented at the National Marine Navigation Meeting of ION, San Diego, California, November 1969.

RAYDIST position data was processed through a hyperbolic conversion program to an x,y coordinate system comparable with previous data collection and analysis methods of the AN program. For the analysis, the straight leg of the Craighill Channel and the straight leg of the Craighill Channel Upper Range were treated separately. Each leg was divided into 475-foot intervals as shown in Figure 2. These intervals are called "data lines." Crosstrack distance at every data line was then computed for each transit, and all transits in each condition (e.g., with traffic, with no traffic, etc.) were combined. The mean and standard deviation of crosstrack distances at each data line was computed for each condition. These statistics are shown in Section 3 as a plot of the mean at each data line with a band enclosing two standard deviations to either side. The two standard deviation band represents the area in which 95 percent of all ship tracks would be expected to occur under conditions similar to those which were sampled. The placement and width of this band within the boundaries of the channel are together a quantitative description of the set of transits under these conditions and, therefore, of the performance of the aids to navigation or piloting technique variables.

2.2.3 Pilot Task and Command Data

As part of understanding the pilotage process in a given geographic area, it is necessary to understand what information the pilot uses and identify the individual activities which comprise his pilotage. Consequently, all rudder orders, course orders, and engine orders were recorded on a time line. Additional attention was given to the following:

- a. Position fixing tasks. A description of the aids to navigation used and the navigational instruments employed.
- b. Ship control tasks. The timing, magnitude, and direction of course changes, rudder orders, or propulsion power changes.

In all, there was a major attempt to identify the causal factors involved in the pilotage and to understand what effect these factors may have had on the resultant ship's track.

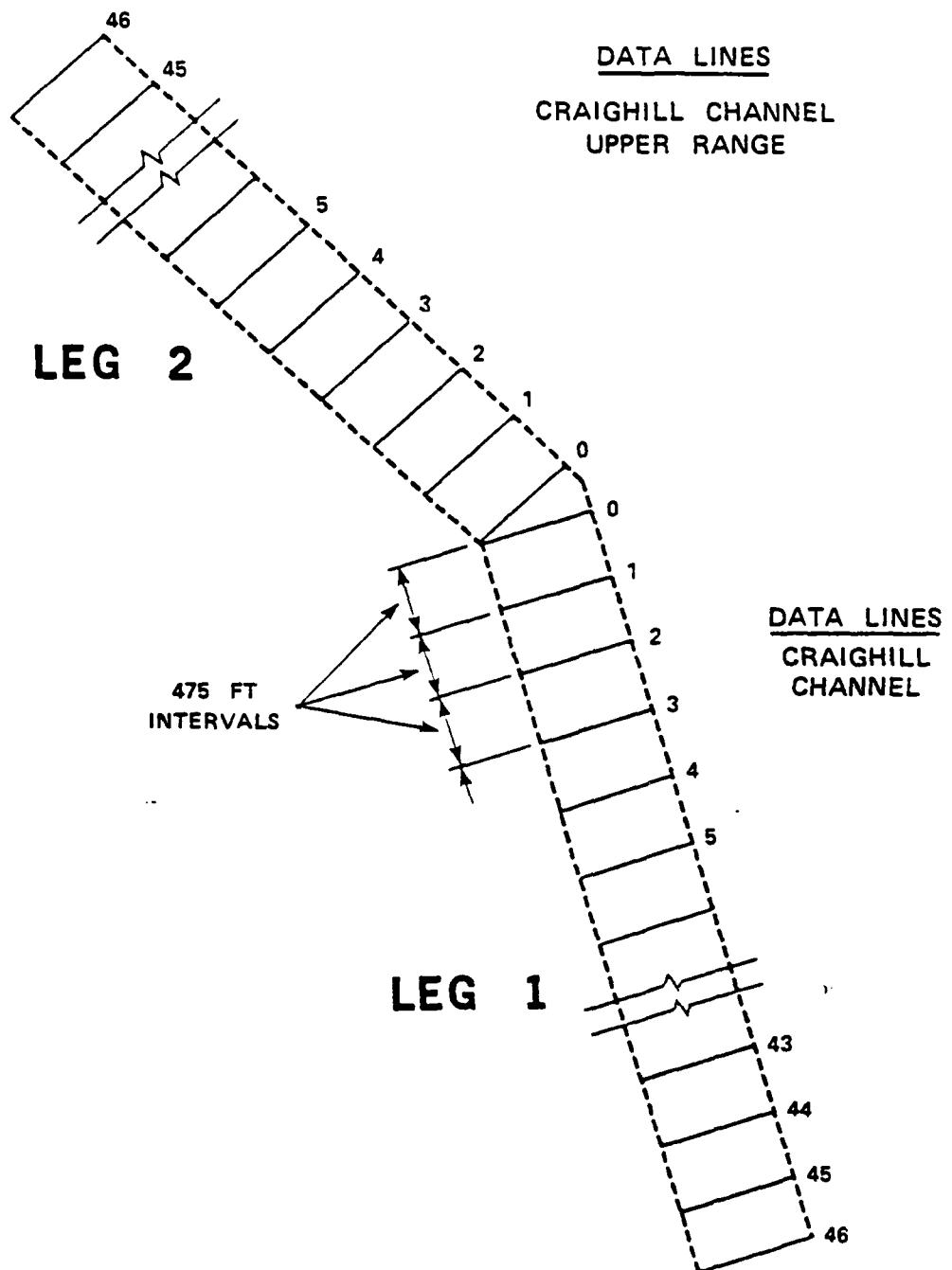


Figure 2. Data Computation Points

(THIS PAGE INTENTIONALLY LEFT BLANK)

Section 3
RESULTS AND CONCLUSIONS

While this experiment represents only the initial, at-sea data collection phase of the simulator validation project, there are some notable results and conclusions worth reporting as potential validation criteria. First of all, the plots shown in this section indicate that, with the exception of traffic, all pilots endeavored to achieve the prescribed goal, that of keeping ownship on the centerline. Secondly, the differences between performance as shown in the plots follows logical rationale. For example, mean tracks of runs with passing traffic were substantially closer to the right side of the channel than mean tracks with no traffic. A wider crosstrack variation (i.e., larger standard deviation) among the group with this traffic was also evident, indicating different types of maneuvers with resultant different closest point of approaches (CPAs).

Some more subtle effects, such as those from wind, were more difficult to identify. In general, however, the results, both of the track plots and from the observations were very much as anticipated. It is concluded that the data which was collected is both valid and appropriate for use in simulator validation.

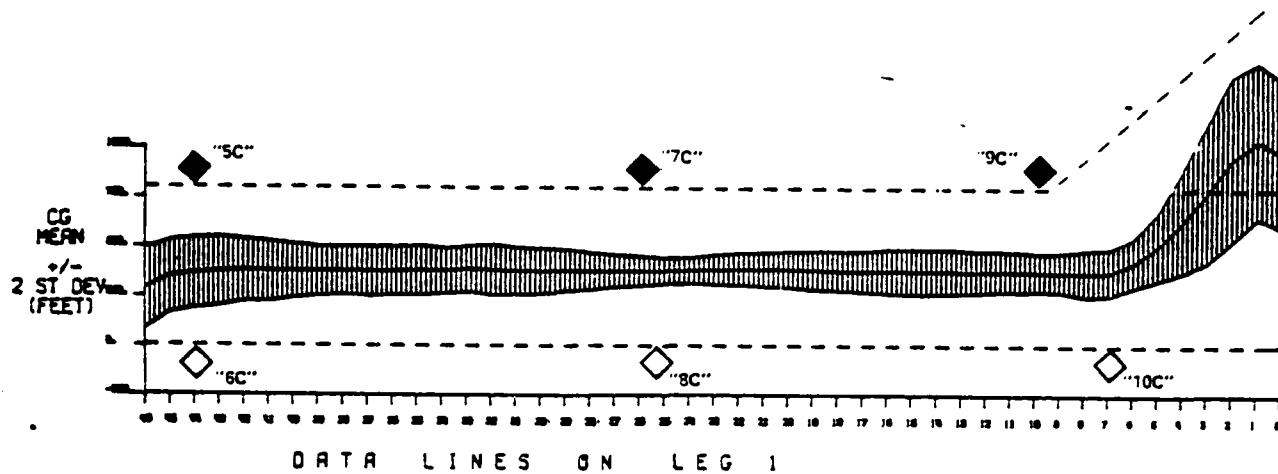
3.1 THE EFFECTS OF VARIABLES ON SHIPHANDLING PERFORMANCE

Four major variables were identified as having the greatest effect on overall shiphandling performance during the pilotage. They were (1) the existence or absence of traffic, (2) the direction of travel, (3) characteristics of the ship, and (4) wind and tidal current conditions. In any subsequent endeavor for the purpose of validating a ship control simulator or ship simulation characteristics, it is recommended that these variables be specifically and individually addressed. The evaluation of shiphandling performance in no way reflects upon pilot proficiency or the way pilots, themselves, perform their pilotage. Instead, the evaluation attempts to identify how pilotages differ as a result of the variables, and whether or not these effects reoccur in the simulation. Aside from conclusions that the data collected is appropriate to administer in a validation experiment, some additional findings are presented in a discussion of the track plots. These findings are presented as potential simulator validation criteria.

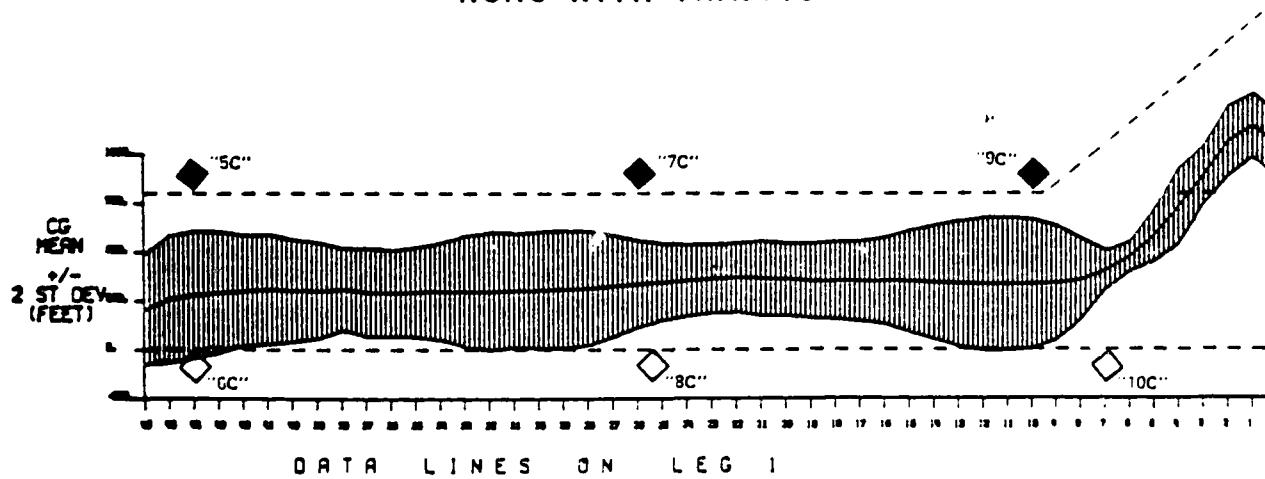
3.1.1 The Effect of Traffic on Performance

As is illustrated in Figures 3 and 4, the existence of traffic in the channel during transits had the greatest overall effect on shiphandling performance of any other variable identified. All of the tracks analyzed are for inbound transits. All encounters were port-to-port meeting situations which are shown on the plots as bulges in the crosstrack deviation. On Figure 3, CPAs occurred almost abeam buoy "6C," just before "8C," and abeam "9C." On Figure 4, the largest maneuver for traffic occurred between "15C" and "17C." Other maneuvers were less prominent. In all transits with traffic the resultant mean

RUNS WITH NO TRAFFIC



RUNS WITH TRAFFIC

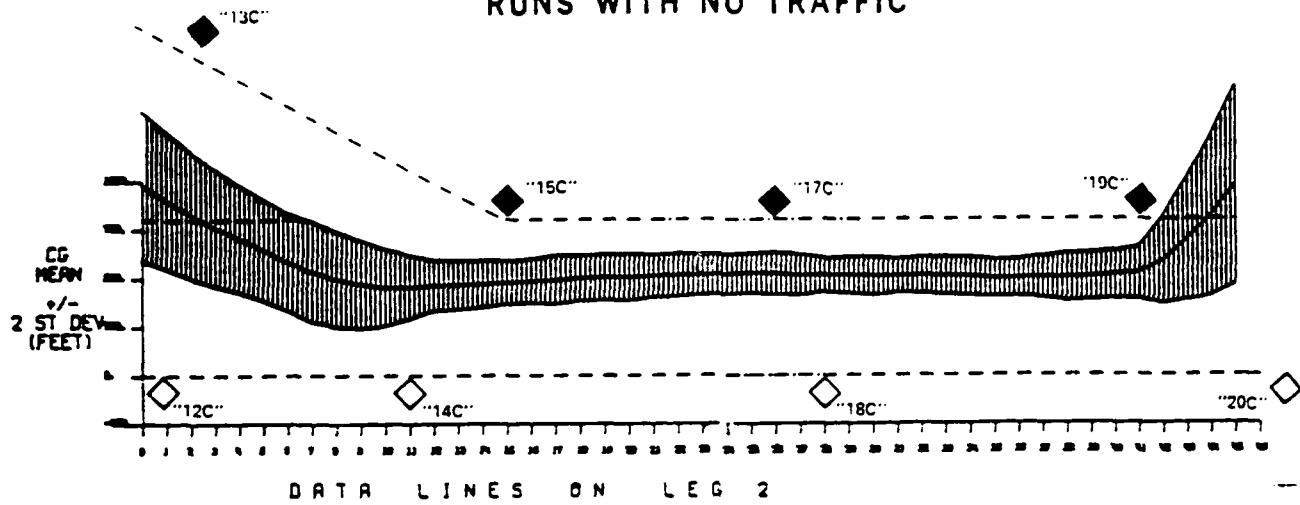


1 DATA LINE = 475 FEET

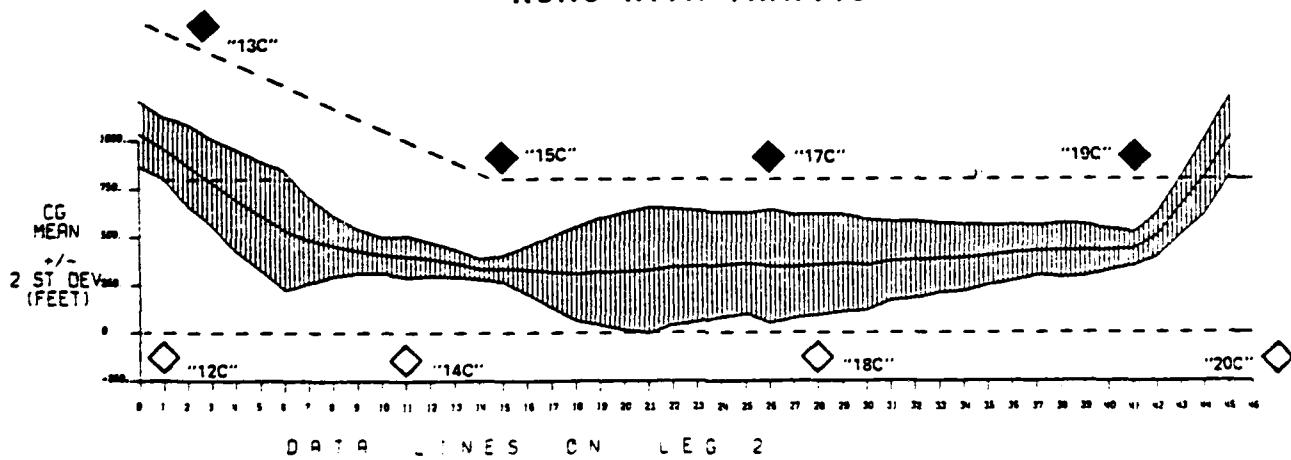
NOTE: Buoys are positioned for the purpose of illustration and may not appear in their exact charted location.

Figure 3. Effect of Traffic on Performance, Leg 1

RUNS WITH NO TRAFFIC



RUNS WITH TRAFFIC



1 DATA LINE = 475 FEET

NOTE: Buoys are positioned for the purpose of illustration
and may not appear in their exact charted location.

Figure 4. Effect of Traffic on Performance, Leg 2

(THIS PAGE INTENTIONALLY LEFT BLANK)

track was just slightly to the right of the centerline. This is understandable since pilots immediately returned to the centerline once they were clear of the traffic ship. Runs with no traffic were of consistent and significantly narrower width. Their mean track was exactly on the centerline in leg 1 and slightly left of centerline in leg 2.

It can be concluded from this analysis that given ship types, traffic encounters and a waterway comparable to that evaluated, ship tracks resulting from simulation should produce the following characteristics:

With No Traffic

- A mean displaced no more than 50 feet off the centerline of the channel for much of the transit with a maximum displacement of no more than 100 feet
- A standard deviation of approximately 63 feet for much of the transit with a maximum standard deviation of no more than 88 feet

With Traffic (conditions approximately those observed)

- A mean displaced no more than 200 feet off the centerline of the channel
- A standard deviation at a CPA of no more than 175 feet

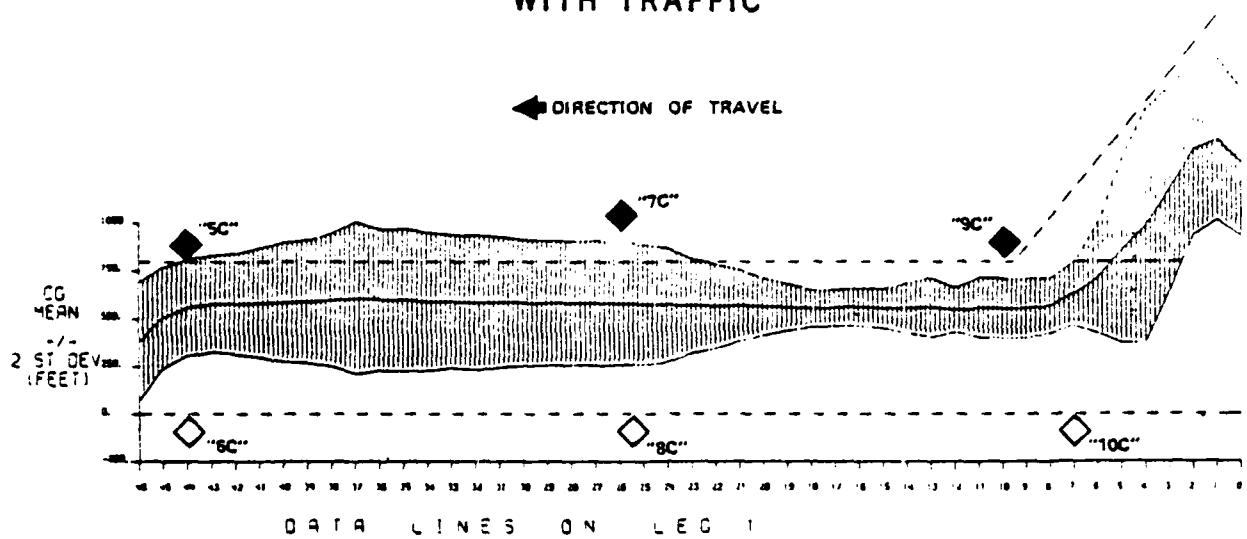
These values were obtained through the at-sea data collection described herein and they are illustrated by Figures 3 and 4.

3.1.2 The Effect of Direction on Performance

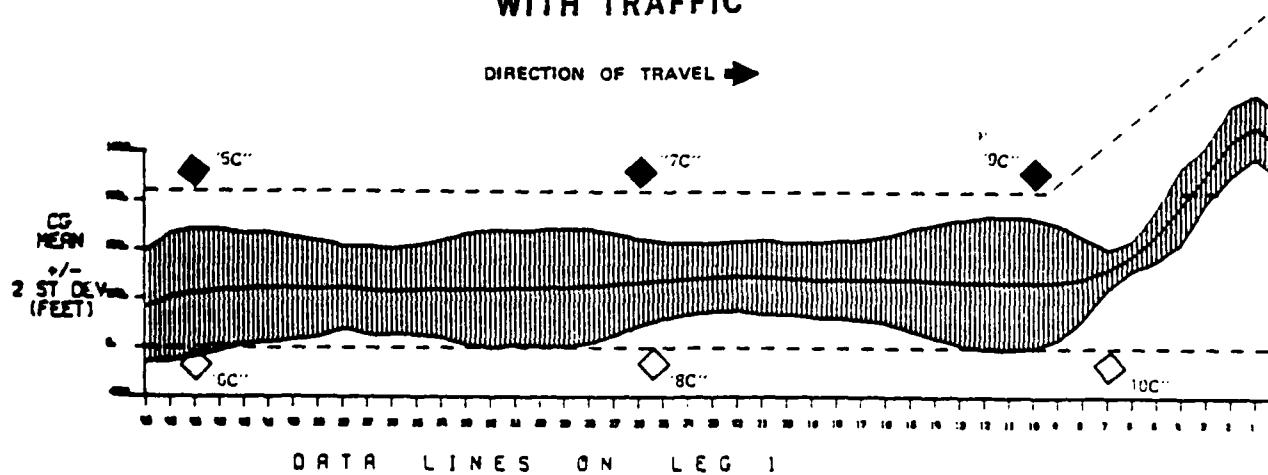
Direction of ship travel through the waterway, in itself, should have had no effect on shiphandling performance. With traffic, it would be expected that the mean track would appear on the right side of the centerline. Consequently, "CPA bulges" in the plot might also extend to the right channel boundary. There should, however, be no other apparent differences between inbound and outbound whether traffic was present or not. Due to limitations in the sample size, Figure 5 shows the effects of direction with traffic, but only for leg 1. Figure 6, on the other hand, shows the effects of direction with no traffic, but only for leg 2. Although they represent different legs, comparisons can be made to illustrate differences as a function of direction.

A comparison between inbound and outbound plots in Figure 5 shows differences in (1) where the traffic was passed and (2) the amount of maneuvering or size of berth which ownship gave to the traffic. In reviewing individual runs which comprised the outbound run plot, Figure 5 shows that one of the passings required ownship to maneuver well into the right outside quarter of the channel. It was this particular maneuver which produced both the large, lengthy bulge in the plot, and a subsequent overall mean track well to the right. Since this was an

OUTBOUND RUNS WITH TRAFFIC



INBOUND RUNS WITH TRAFFIC

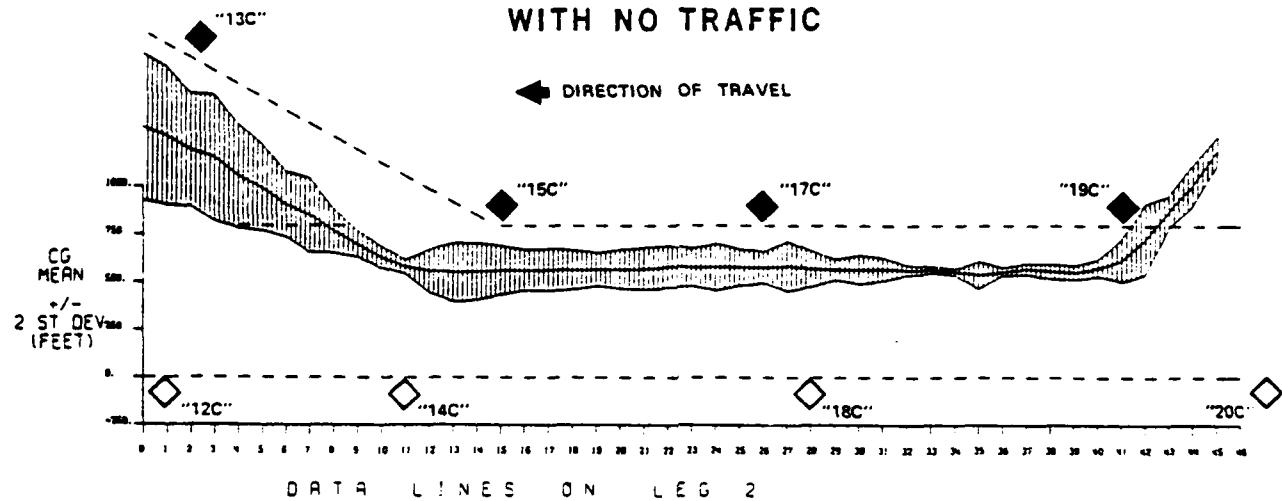


1 DATA LINE = 475 FEET

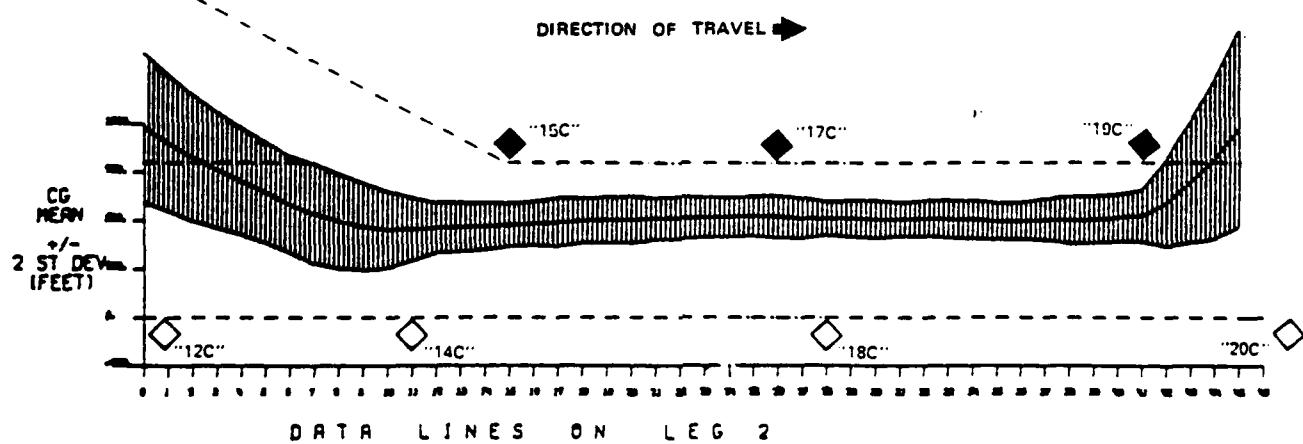
NOTE: Buoys are positioned for the purpose of illustration and may not appear in their exact charted location.

Figure 5. Effect of Direction on Performance, With Traffic

OUTBOUND RUNS WITH NO TRAFFIC



INBOUND RUNS WITH NO TRAFFIC



1 DATA LINE = 475 FEET

NOTE: Buoys are positioned for the purpose of illustration and may not appear in their exact charted location.

Figure 6. Effect of Direction on Performance, With No Traffic

(THIS PAGE INTENTIONALLY LEFT BLANK)

unusually large maneuver, it demonstrates how differently pilots react to traffic; and in particular, the need to address simulator validation with traffic as a whole separate issue.

With no traffic (Figure 6), inbound and outbound plots appear quite similar. The more jagged appearance of the outbound plot is caused by smaller sample size; however, average width of the plot and location of the mean trackline are approximately the same. There were no major shiphandling differences indicated as a result of which direction in the waterway ownship was traveling. It was concluded that because the configuration of aids to navigation were very similar in both directions (i.e., almost all were gated buoys), their arrangement did not have a major effect on pilotage.

3.1.3 The Effect of Ship Characteristics on Performance

Figures 7 through 10 illustrate the effects on shiphandling performance of ship design characteristics. Two categories of ship length were selected, those under 650 feet length-overall (LOA) and those over 650 feet LOA. Two categories of ship breadth were selected, those under 90-foot beam and those over 90 foot beam. The 650-foot LOA and 90-foot beam limit was based on the data available to achieve an equal sample size in each category and no other particular criteria. As a result, the smaller category consisted of two tankers, one container vessel, and the remainder were small 18,000 dwt to 32,000 dwt bulk carriers. The larger category consisted of all 30,000 dwt to 63,000 dwt bulk carriers. Owing to variations in hull design, some ships were in the larger length category, but smaller breadth category. Nevertheless, a review of all four figures shows high correlation in performance among the larger categories and among the smaller categories. In general, the "larger" ships produced a wider deviation plot than did the "smaller" ships.

It can be concluded from the analysis that design characteristics of ships, specifically their size, does have an effect on shiphandling performance. This effect can be quantified for the purpose of simulator validation as follows:

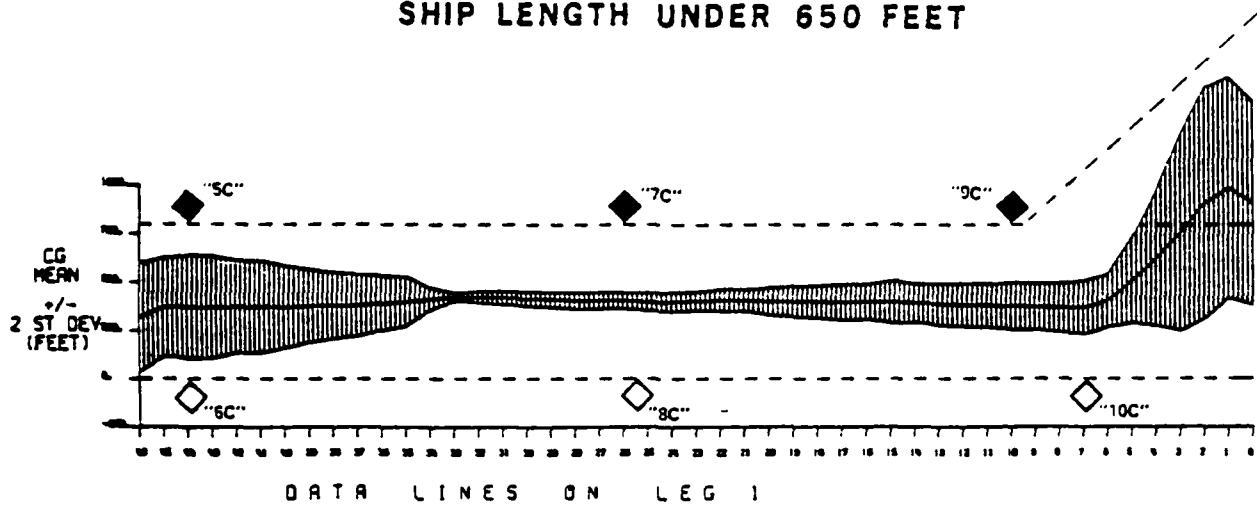
A Ship With Length Under 650 Feet and Beam 90 Feet or Less

- A mean displaced no more than 50 feet from the channel centerline anywhere in the transit
- A standard deviation of approximately 38 feet with extremes along the transit varying from 25 to 75 feet

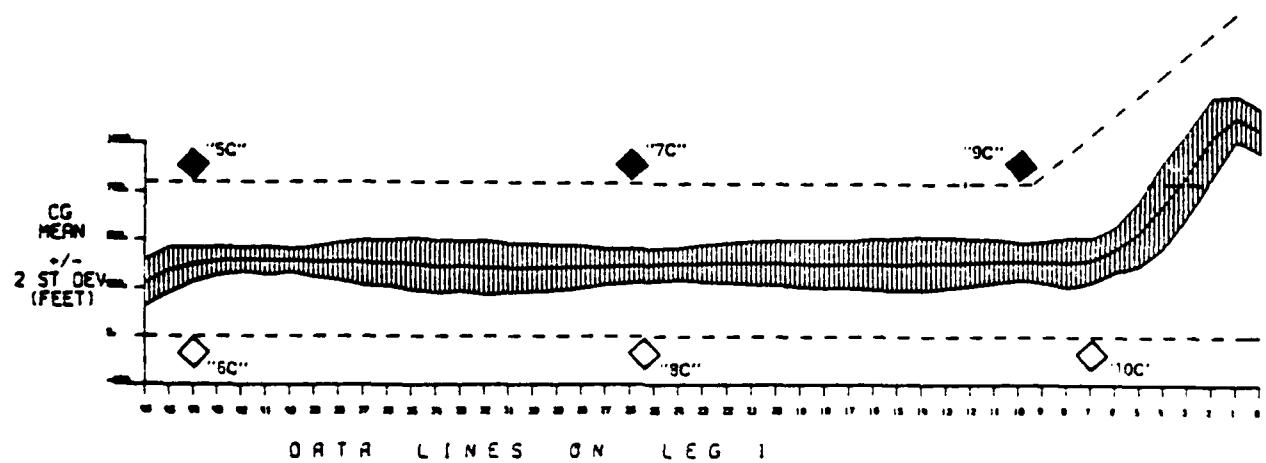
A Ship With Length Over 650 Feet and Beam Over 90 Feet

- A mean displaced no more than 100 feet from the channel centerline anywhere in the transit
- A standard deviation of approximately 250 feet with extremes along the transit varying from 200 to 300 feet

SHIP LENGTH UNDER 650 FEET



SHIP LENGTH OVER 650 FEET

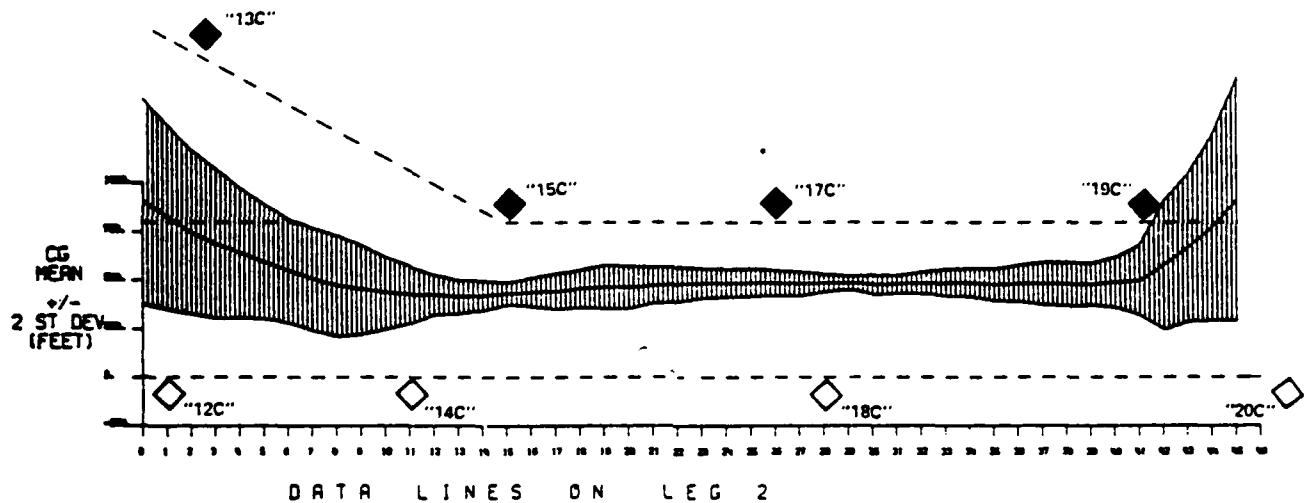


1 DATA LINE = 475 FEET

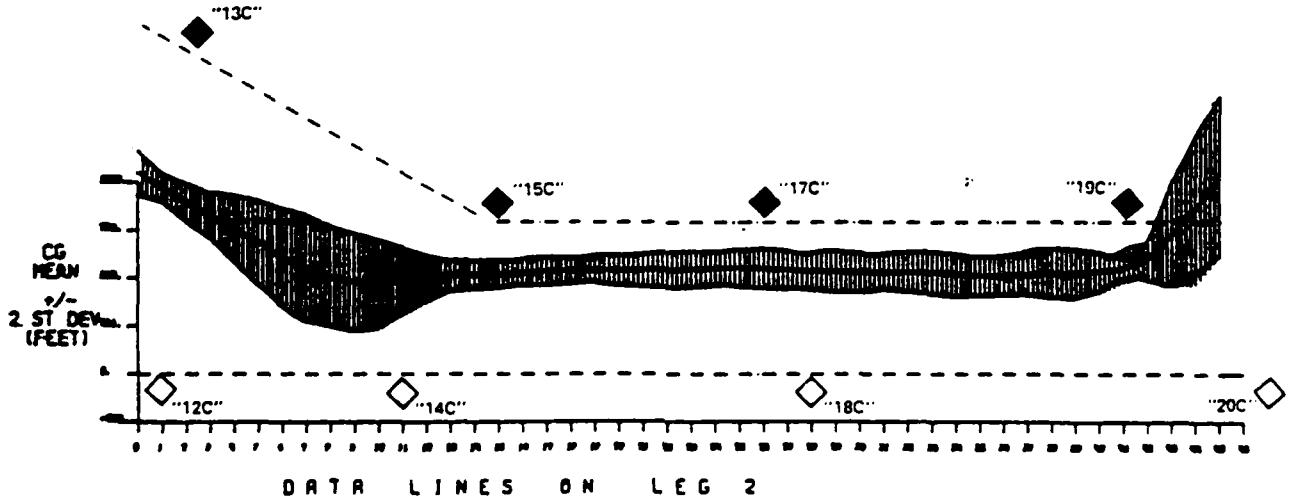
NOTE. Buoys are positioned for the purpose of illustration and may not appear in their exact charted location.

Figure 7. Effect of Ship Length on Performance, Leg 1

SHIP LENGTH UNDER 650 FEET



SHIP LENGTH OVER 650 FEET

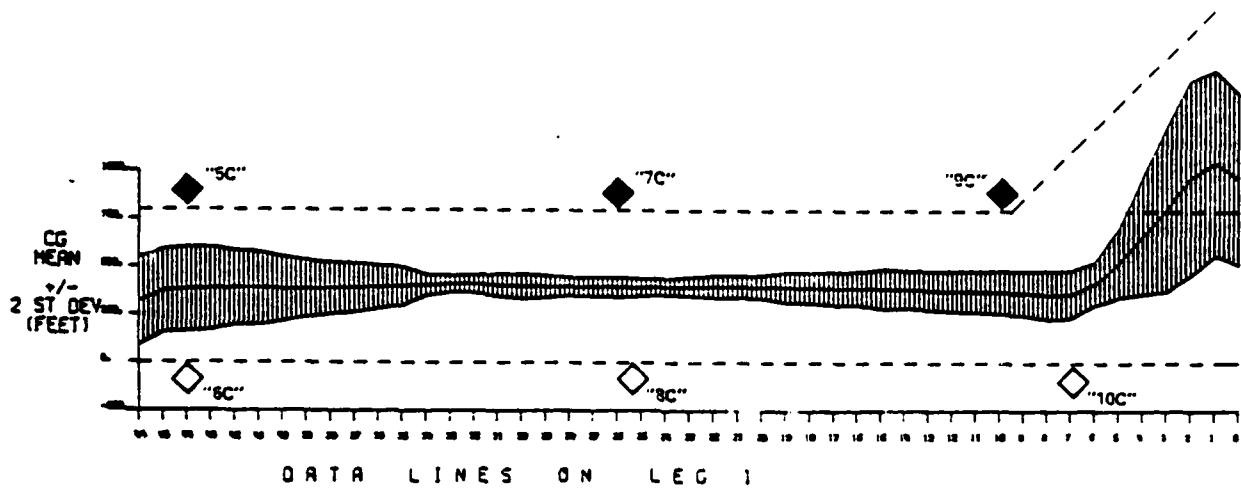


1 DATA LINE = 475 FEET

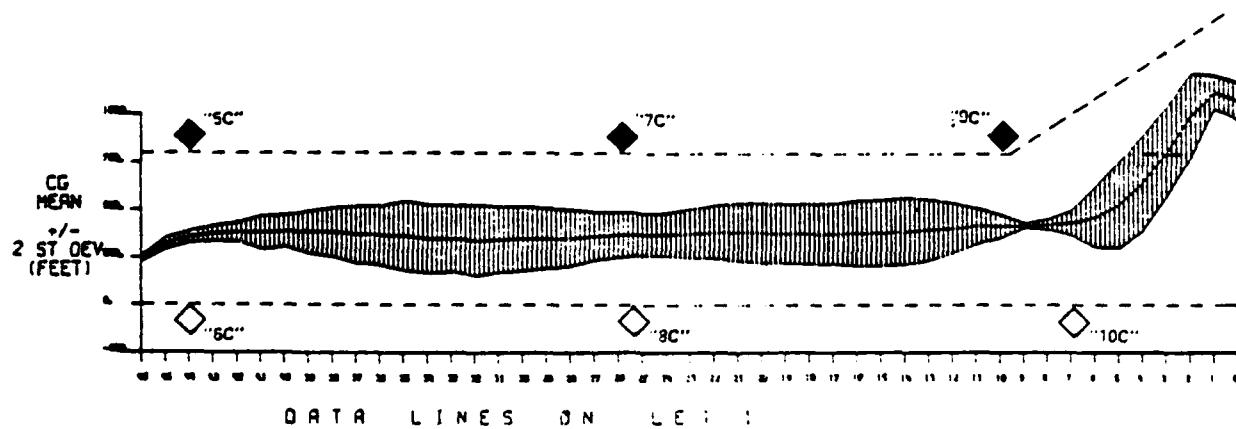
NOTE: Buoys are positioned for the purpose of illustration and may not appear in their exact charted location.

Figure 8. Effect of Ship Length on Performance, Leg 2

SHIP BEAM 90 FEET OR LESS



SHIP BEAM OVER 90 FEET

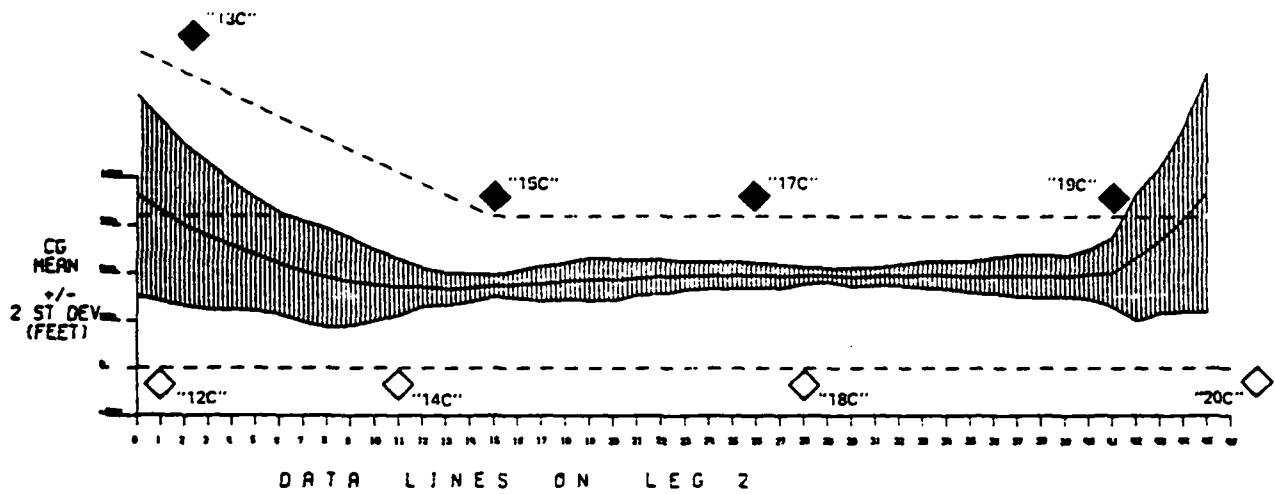


1 DATA LINE = 475 FEET

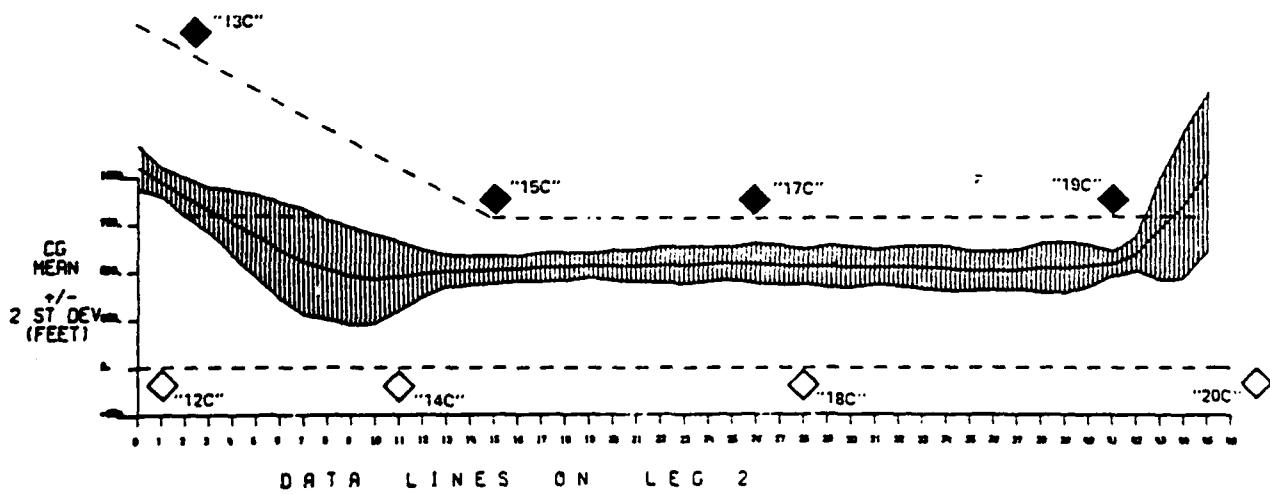
NOTE: Buoys are positioned for the purpose of illustration and may not appear in their exact charted location.

Figure 9. Effect of Ship Beam on Performance, Leg 1

SHIP BEAM 90 FEET OR LESS



SHIP BEAM OVER 90 FEET



1 DATA LINE = 475 FEET

NOTE: Buoys are positioned for the purpose of illustration and may not appear in their exact charted location.

Figure 10. Effect of Ship Beam on Performance, Leg 2

(THIS PAGE INTENTIONALLY LEFT BLANK)

From the above results (and their comparison with Figures 3 and 4), it is obvious that the smaller ships performed better than the larger ships in terms of track variability (standard deviation). A similar finding was shown in a simulator experiment which evaluated performance differences between a 30,000 dwt and an 80,000 dwt tanker.¹⁴ It is recommended that for simulator validation purposes two ship sizes be used.

3.1.4 The Effect of Environment on Performance

The effects of wind speed and tidal current on shiphandling performance are addressed separately and should be accorded separate validation. Wind direction which prevailed from the northwest is shown in Figures 11 and 12. Tidal current average speed and direction are shown in Figures 13 and 14.

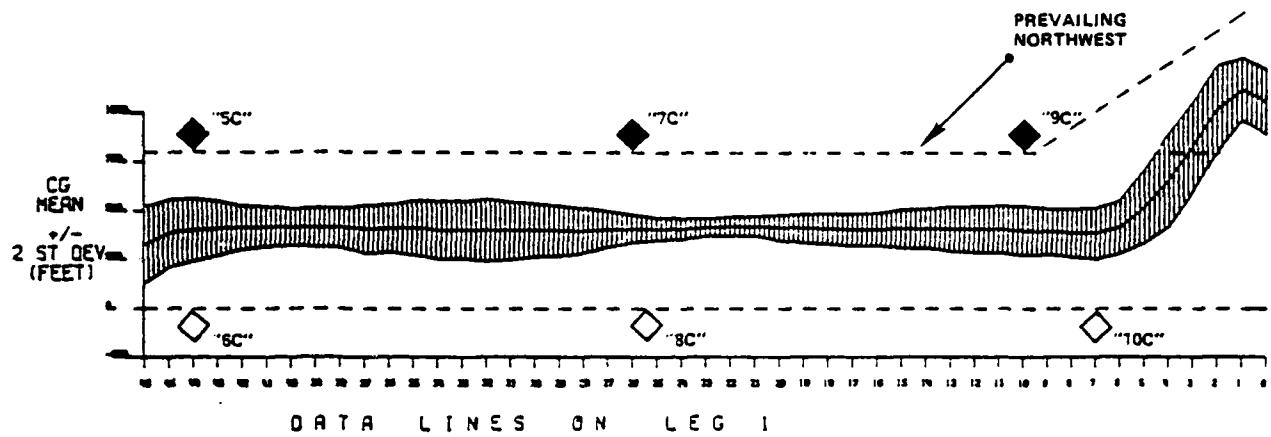
Effects of Wind Speed. A review of Figure 11 indicates that while wind speed had no effect on variability of tracks (i.e., crosstrack standard deviation), the mean track for runs with wind speed over 10 knots is set an average of 50 feet to leeward. Figure 12 on the other hand shows mean tracks for both conditions in identical locations. Relative wind in this case, however, was approximately 30 degrees closer on the bow. It is concluded from this analysis that relative wind speed up to 20 knots at 10 to 20 degrees off the bow will not effect variability of pilots trackkeeping. There is some indication, however, that wind of this same speed but broader on the beam begins to set the vessel at a rate which is either not perceived by the pilots, or is not a concern to them in the conduct of their pilotage.

It is concluded that this information on the effect of wind and on shiphandling performance is usable for simulator validation. It is recommended, however, that before its implementation more detailed validation criteria be developed by further analyzing the interaction effects of different wind speeds from different directions.

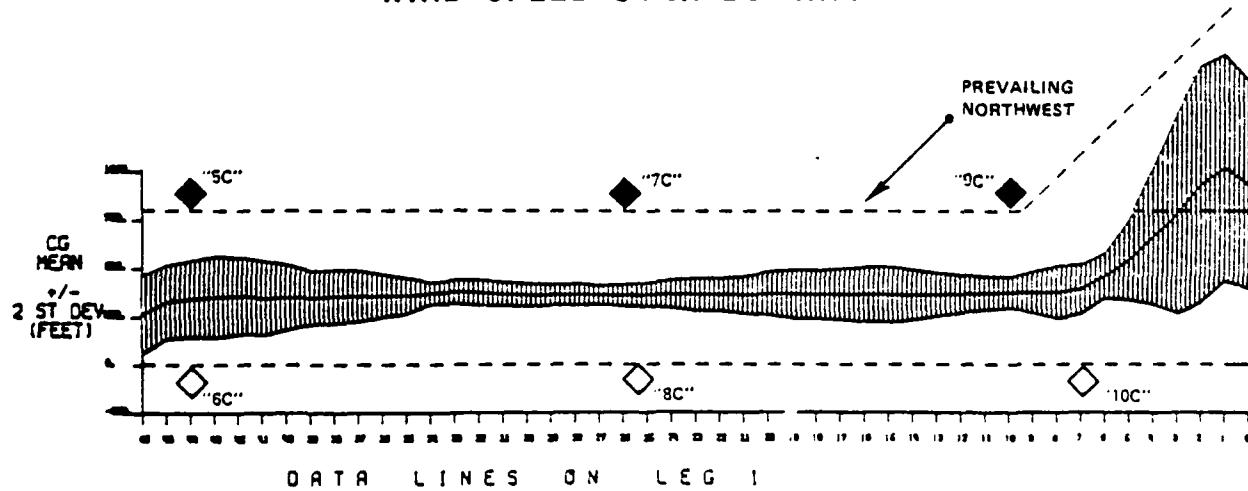
Effects of Tidal Current. Figures 13 and 14 show these different segments of the tidal cycle: ebb, flood, and slack current. All transits are inbound moving left to right on the plots. While flow at maximum flood or ebb can approach as much as 0.9 knots in the Upper Chesapeake Bay, speeds calculated for the times at which transits were conducted never exceeded 0.5 knots. Current vectors indicated on the figures were derived from the Tidal Current Charts of the Upper Chesapeake Bay (Second Edition, 1973). The arrows are positioned to show the direction of flow on the surface of the channel and not the location of the measurement station. Pilots contend that the tidal current may actually flow even more parallel to the channel than illustrated. As a result, it is concluded that relatively little crosscurrent actually existed in any of the transits at the time data was collected, and that the flow which was experienced was actually in the form of head or following current.

¹⁴W.R. Bertsche, D.A. Atkins, and M.W. Smith, op. cit.

WIND SPEED UNDER 10 KNOTS



WIND SPEED OVER 10 KNOTS

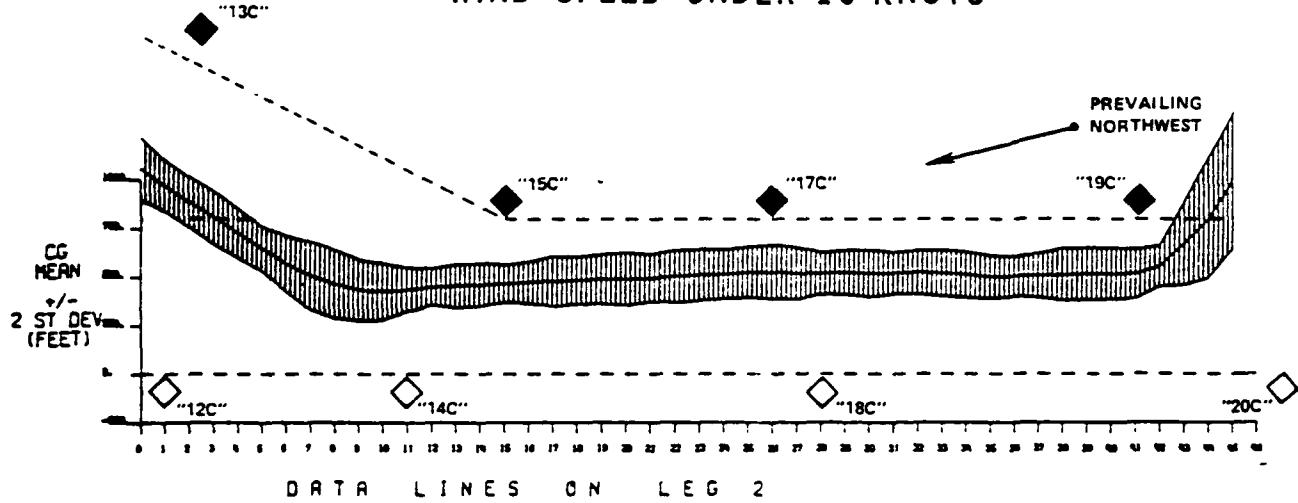


1 DATA LINE = 475 FEET

NOTE: Buoys are positioned for the purpose of illustration and may not appear in their exact charted location.

Figure 11. Effect of Wind Speed on Performance, Leg 1

WIND SPEED UNDER 10 KNOTS



WIND SPEED OVER 10 KNOTS

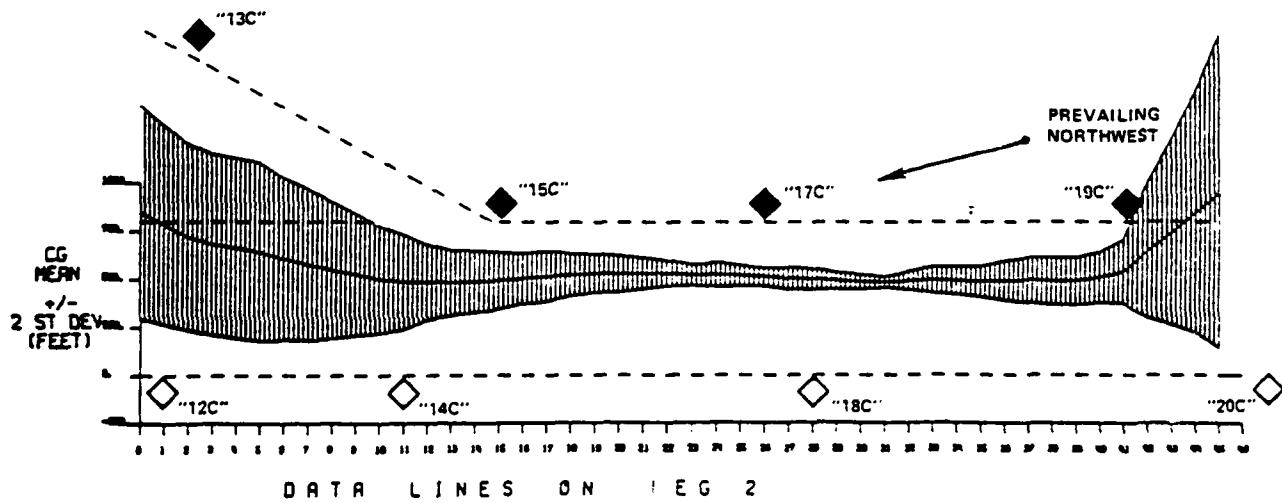
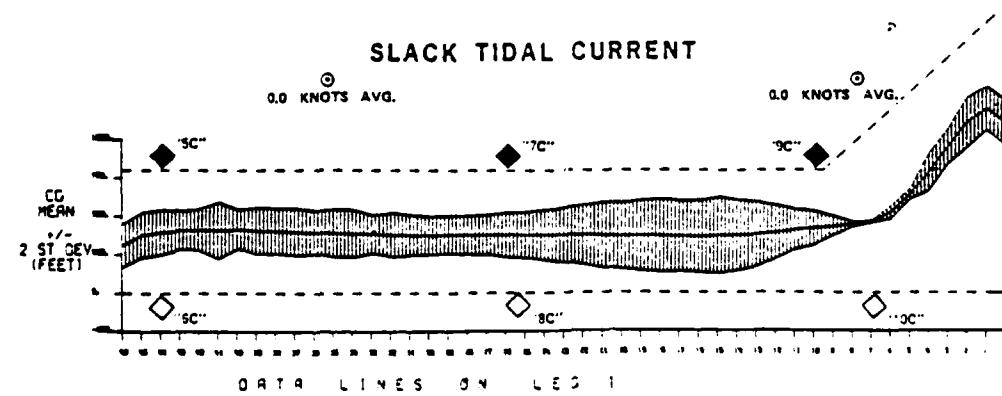
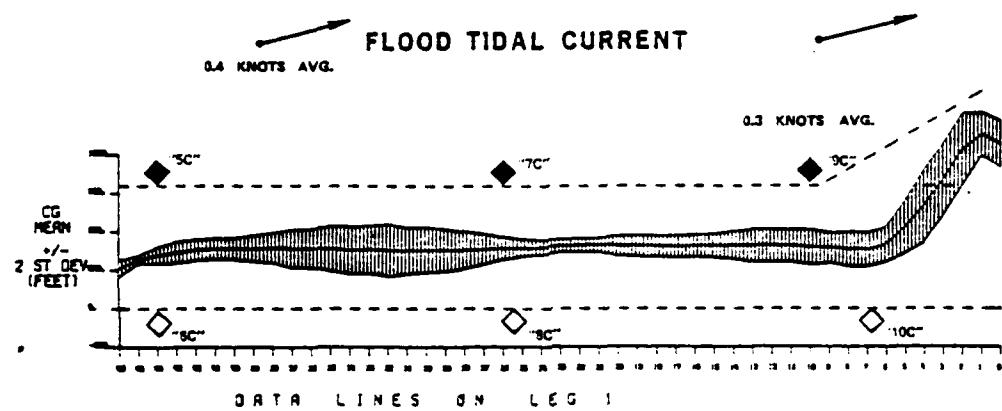
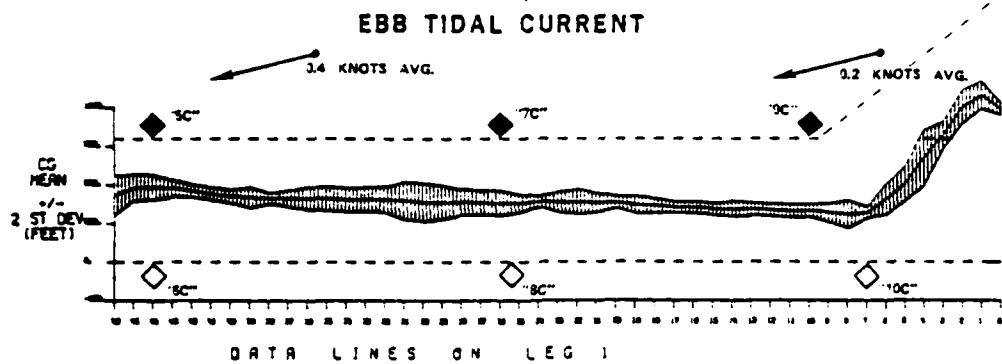
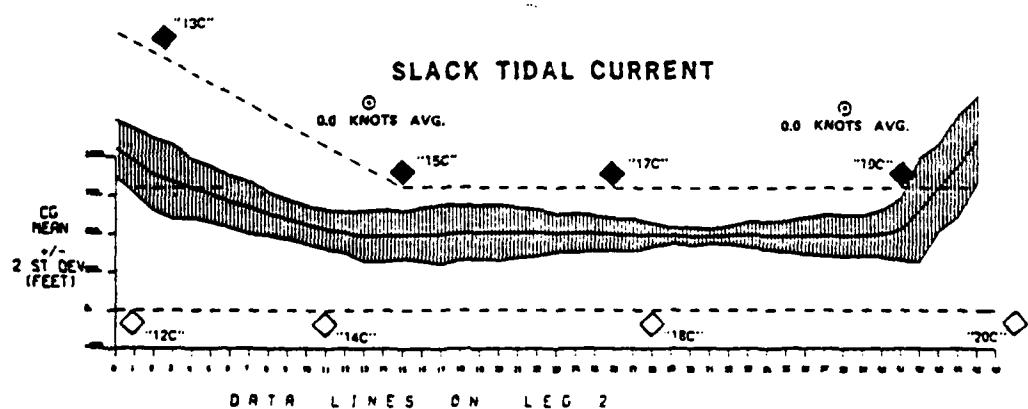
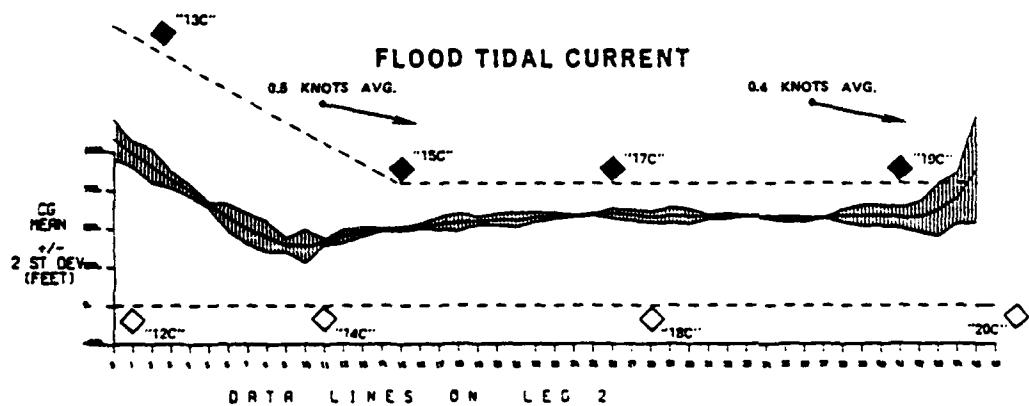
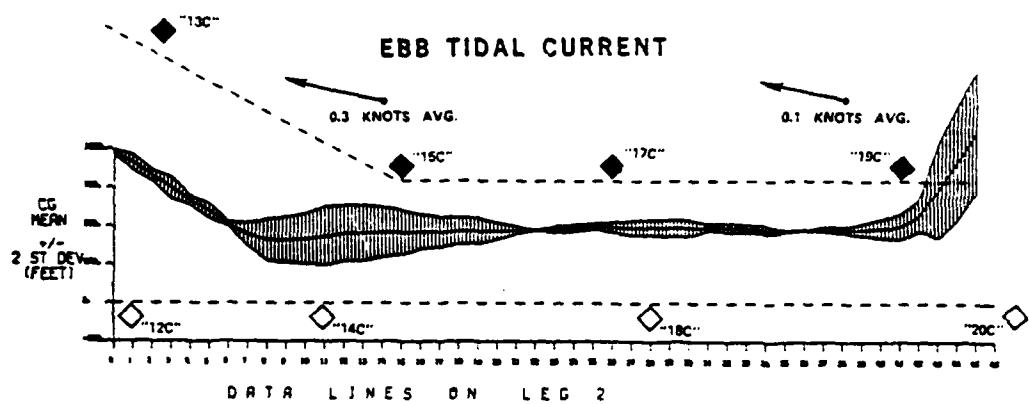


Figure 12. Effect of Wind Speed on Performance, Leg 2



1 DATA LINE = 475 FEET
 NOTE: Buoys are positioned for the purpose of illustration
 and may not appear in their exact charted location.

Figure 13. Effect of Tidal Current on Performance, Leg 1



1 DATA LINE = 475 FEET
 NOTE: Survey lines are positioned for the purpose of illustration and may not appear in their exact charted location.

Figure 14. Effect of Tidal Current on Performance, Leg 2

Figure 13 shows very comparable (i.e., 0.4 knots and 0.2 to 0.3 knots) average speed for both ebb and flood tidal currents. Its effect on shiphandling performance as indicated by the plots shows possibly more ship control with the head current (i.e., ebb in this case). While this is easy to understand, it is surprising that an average 0.3-knot head current could significantly influence the control of a 10- to 12-knot ship. A review of mean tracks on Figure 13 shows that all are within 50 feet of the centerline and that there is no apparent set as a result of the current.

Figure 14 which is the second leg of the waterway, also shows relatively little effect of the current upon shiphandling. The major difference appears to be in the turn abeam buoy "14C." With ebb and slack tidal current, the mean track shows a gradual turn with little or no overshoot. On the flood current plot, a large overshoot is in evidence. Alignment of the mean track through the straight of the channel is the same for all three plots.

It is concluded, as a result of the analysis of shiphandling performance, that the data collected at sea is not sufficient for validating the effects of crosscurrent in simulators. This conclusion is based on a lack of sufficient data on crosscurrents of varying angles and magnitudes. The currents experienced at sea were not shown to have affected shiphandling performance except at one bend. It is recommended that the data can be used for validating comparable head or following current conditions, but any extrapolation of results to crosscurrent simulation would be speculative. The following conclusions apply with respect to using this data for simulator validation:

- There will be no verifiable difference in shiphandling performance between a ship traveling in excess of 8 knots in slack water, and one with a head or following current at less than 1/2 knot with angles relative to the bow or stern up to 20 degrees.
- Criteria for the validation of crosscurrent effects in simulators cannot be derived from this data.

3.2 UTILIZATION OF DATA IN SIMULATOR VALIDATION

In recognizing the complexity of the restricted waterway pilotage process and the critical nature of the research being conducted on simulators, there is sufficient justification for concern over simulator and simulation validity. The intent of this project was to obtain real world data at sea for the purpose of developing validation criteria and eventually applying it in a validation of the U.S. Coast Guard simulator located at Eclectech Associates in North Stonington, Connecticut. The overwhelming conclusion of this report is that the intent of the effort has been met. It should be apparent to the reader that the validation required of this simulator does not include all potential aspects of the pilotage. For example, there is no requirement to validate channel bank effects, slow speed maneuvering and docking effects, or the effects of heavy seas and weather. The validation should, instead, address only

those factors which are of concern to the aids to navigation research. These factors are ship hydrodynamic response at maneuvering and sea speed, the effects of normal environment on shiphandling, the effects of waterway design including aids to navigation, and pilot capabilities.

The at-sea data collection has provided a wealth of information not only in the form of track plots, but also on ship environment and pilot task characteristics. The analysis of track plots presented in section 3.1 should provide the first and most beneficial data for deriving validation criteria. Information contained in Appendix A and Table 1 can be further reduced if "cause and effect" is to be addressed in the validation.

In summary, this report recommends that data derived from the plots (Figures 3 through 13), and in some instances, the pilots themselves, be compared directly to previous simulation data from the AN program; and that this comparison, in itself, will provide a tentative form of validation. The report also recommends that special simulation be designed and conducted expressly for the purpose of performing a validation. This will require the development of specific validation criteria from the at-sea data, and a determination of what characteristics of each scenario will best accommodate the criteria. Finally, the absence of good crosscurrent information from the at-sea data suggests that if further opportunities should arise for ship tracking, this data base might be expanded to include a number of samples of different crosscurrent angles and relative velocities.

(THIS PAGE INTENTIONALLY LEFT BLANK)

BIBLIOGRAPHY

Bertsche W.R., D.A. Atkins, and M.W. Smith. "Aids to Navigation Principal Findings Report on the Ship Variables Experiment: The Effect of Ship Characteristics and Related Variables on Piloting Performance." U.S. Coast Guard, Washington, D.C., April 1981.

Bertsche, W.R. and R.C. Cook. "Analysis of Visual Navigational Variables and Interactions." U.S. Coast Guard, Washington, D.C., October 1979.

Bertsche, W.R. and R.T. Mercer. "Aids to Navigation Configurations and the Physical Characteristics of Waterways in 32 Major U.S. Ports." U.S. Coast Guard, Washington, D.C., October 1979.

Cooper, R.B., K.L. Marino, and W.R. Bertsche. "Simulation Evaluation of Electronic Radio Aids to Navigation Displays, The RA-2 Experiment." U.S. Coast Guard, Washington, D.C., April 1981.

Cooper, R.B., K.L. Marino, and W.R. Bertsche. "Simulation Evaluation of Electronic Radio Aids to Navigation Displays, The RA-1 Experiment." U.S. Coast Guard, Washington, D.C., January 1981.

Cooper, R.B. and K.L. Marino. "Simulator Evaluation of Electronic Radio Aids to Navigation Displays - The Miniexperiment." U.S. Coast Guard, Washington, D.C., September 1980.

Hastings, C.E., and A.L. Comstock. "Pinpoint Positioning of Surface Vessels Beyond Line-of-Sight." A paper presented at the National Marine Navigation Meeting of ION, San Diego, California, November 1969.

Marino, K.L., M.W. Smith, and W.R. Bertsche. "Aids to Navigation Principal Findings Report: The Effect of One-Side Channel Marking and Related Conditions on Piloting Performance." U.S. Coast Guard, Washington, D.C., July 1981.

Smith, M.W. and W.R. Bertsche. "Aids to Navigation Principal Findings Report on the Channel Width Experiment: The Effects of Channel Width and Related Variables on Piloting Performance." U.S. Coast Guard, Washington, D.C., January 1981.

Smith, M.W. and W.R. Bertsche. "Aids to Navigation Report on the CAORF Experiment. The Performance of Visual Aids to Navigation as Evaluated by Simulation." U.S. Coast Guard, Washington, D.C., August 1980.

Appendix A
INDIVIDUAL RUN DATA

This appendix contains both raw data manually recorded by observers aboard each ship during each transit, and the composite ship track computed and plotted from RAYDIST tracker data.

SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm ≥ 5 nmSun-moon brilliance: BRIGHT FULL HAZY-QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT /STARBOARDAir temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE2 hours 29 minutes since slack FLOOD EBB (circle one) from tables7 hours 11 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>USCG Buoy Tender</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>2900 hp</u>	at	<u>RPM</u>
Length overall	<u>157</u>	(units)	<u>ft</u>
Length between perpendiculars	<u> </u>	(units)	<u> </u>
Beam	<u>31</u>	(units)	<u>ft</u>
Depth	<u> </u>	(units)	<u> </u>
Dead weight tonnage	<u>525</u>		
Gross tonnage	<u> </u>		
Net tonnage	<u> </u>		
Design draft	<u> </u>	(units)	<u> </u>
Actual draft	 <u>6'7"</u>	FORWARD,	<u> </u> AFT (units) <u> </u>
Height of eye	<u> </u>	(units)	<u> </u>
Bridge to bow	<u> </u>	(units)	<u> </u>
Bridge to stern	<u> </u>	(units)	<u> </u>
Antenna to ship centerline	<u> </u>	feet	PORT STARBOARD (circle one)
	<u> </u>	feet	AFT of bridge bulkhead

	(rpm)	(knots)
DEAD SLOW	<u> </u>	<u> </u>
SLOW	<u> </u>	<u> </u>
HALF	<u> </u>	<u> </u>
FULL MANEUVERING	<u> </u>	<u> </u>
FULL NAVIGATION	<u> </u>	<u> </u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

 ADVANCE, TRANSFER (units) , minutes seconds

Crash stop to dead in water, DISTANCE (units) , minutes seconds

TRANSIT EVENTS
(local time)

IF INBOUND



13:3600 at Bay Bridge mark
 Ship centerline _____ feet EAST WEST (circle one) of mark
13:4300 on green range
13:4500 on red range
13:5900 abeam Baltimore Light
14:3000 abeam 7 Foot Knoll
— abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
—	Course at start — RPM at start — abeam "1C"	—	
13:3600	Under Bridge	—	
13:4100	Buoy 83 30yds Port Beam 493.10 - Red 1220.76 - Green	—	
13:4300	480.36 Red 1206.63 Green South Range	—	
13:4500	469.27 Red North Range Course 350	—	
13:5200	Abeam "2C" entering Craighill Entrance	—	
13:5900	Abeam Baltimore Light	—	
14:1800	Abeam "10C"	—	
14:2500	Abeam "14C"	—	
14:3000	Abeam 7' Knoll Light	—	
14:3200	Buoy 17-18	—	

RUN 1

United States Coast Guard Buoytender
Red Birch: 0.5 dwt, 157 LOA
Wind: 5 knots

(No tracking data was available for this run.)

SHIP TRACKING REPORT

RUN CONDITION
(circle one)

Direction: INBOUND OUTBOUND

Time: DAY NIGHT

Method: VISUAL RADAR PATH RACON

INITIAL ENVIRONMENT
(circle one)

Weather: STABLE IMPROVING DETERIORATING

Sky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCAST

Precipitation: NONE DRIZZLE RAIN SNOW FOG

Visibility: 1/2 nm 1 nm 3 nm ≥ 5 nm

Sun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE-NEW

Sun-moon direction: FORWARD AFT PORT STARBOARD

Air temperature (F): 30 30-50 51-70 70

Sea temperature (F): 30 30-50 51-70 70

True wind direction: N NE E SE S SW W NW

True wind speed: 3 3-10 11-20 21-30 30

Sea state: CALM SLIGHT SMALL MEDIUM LARGE

1 hours 40 minutes since slack FLOOD EBB (circle one) from tables

2 hours 31 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulk-Coal</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>23,000</u>	at <u>122</u> RPM	
Length overall	<u>856</u>	(units) <u>ft</u>	
Length between perpendiculars	<u>810</u>	(units) <u>ft</u>	
Beam	<u>133</u>	(units) <u>ft</u>	
Depth		(units)	
Dead weight tonnage	<u>130,000</u>		
Gross tonnage	<u>70,363</u>		
Net tonnage	<u>46,166</u>		
Design draft		(units)	
Actual draft	 <u>58</u>	FORWARD, <u>34</u>	AFT (units) <u>ft</u>
Height of eye	<u>96</u>	(units) <u>ft</u>	
Bridge to bow	<u>705</u>	(units) <u>ft</u>	
Bridge to stern	<u>151</u>	(units) <u>ft</u>	
Antenna to ship centerline	<u>0</u>	feet PORT STARBOARD	(circle one)
	<u>0</u>	feet AFT of bridge bulkhead	

	(rpm)	(knots)
DEAD SLOW	<u>40</u>	<u>5.5</u>
SLOW	<u>60</u>	<u>8</u>
HALF	<u>70</u>	<u>10</u>
FULL MANEUVERING	<u>80</u>	<u>11</u>
FULL NAVIGATION	<u>116</u>	<u>15</u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data **MEAN DRAFT (units)** , **RPM**

ADVANCE. TRANSFER (units) . minutes seconds

Crash stop to dead in water. DISTANCE (units) minutes seconds

NOT NOTED

TRANSIT EVENTS
(local time)

IF INBOUND

19:5000 at Bay Bridge mark
 Ship centerline feet EAST WEST (circle one) of mark
 on green range
 on red range
 abeam Baltimore Light
 abeam 7 Foot Knoll
 abeam "4B"

IF OUTBOUND

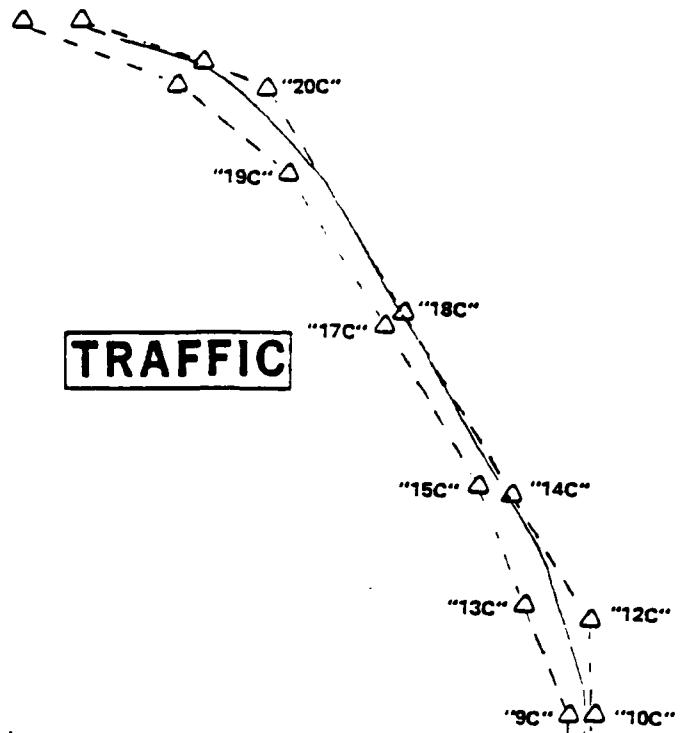
Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
<u>19:5000</u>	Course at start <u>018</u>	20:1345	RR10
5300	RPM at start <u>110</u>	1355	MS
	abeam "1C"	1400	RL10
5500	Abeam "83"	1418	MS
5600	Abeam Sandy Point	1500	RR05
5710	RL15	1520	CC359
5700	MS	1644	CC000
5721	RR10	1948	RR15
	MS	1955	MS
5808		2014	RL10
5836	RR10	2016	MS
20:0000	CC343	2020	CC001
0400	Freighter traffic abeam	2050	Slow to 95 rpm to stop vibration
0600	Abeam 2C-tug ahead		
	Tug abeam	2335	CC000
0900	CC342	2600	CC002
1300	RR20		

Local Time	Event	Local Time	Event
20:3000	RL10	20:4940	Traffic rounding turn ahead
3030	CC345	5023	Slow ahead
3510	RL10	5300	RR10
3520	RL20	5310	Half ahead
3530	RR10	5321	MS
3545	MS	5340	RR10
3550	RR10	5350	RR20
3625	MS	5400	Traffic abeam - Bulker
3638	RR10	5432	Full ahead
3700	MS	5507	RR05
3720	CC331	5515	RR10
3800	Half ahead - Traffic ahead outbound	5552	MS
3900	CC332	5615	RR10
3930	Slow ahead	5650	MS
4043	CC334	5752	RR05
4255	CC332 - Pilot noted helmsman tends to steer left - pilot compensating with orders	5800	MS
		21:0230	CC292
4517	CC330	0400	CC290
4640	Dead slow ahead	0500	CC292
4700	CC334		

TAPE IN ENVELOPE?

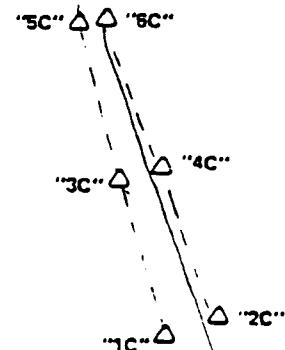
* USCG initial _____



(Tracking error was caused
by inability to initialize
on raydist ranges at night)

INBOUND
NIGHT RUN

NO TRAFFIC



RUN 2

BULKER: 130 K, 810 LOA
WIND: 5 KTS
CURRENT: EBB (0.6 KT AVG)

1" = 1 KT
1" = 1.0 NM
3/32" = 1 d l

SHIP TRACKING REPORT

RUN CONDITION

(circle one)

Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT

(circle one)

Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm ≥ 5 nmSun-moon brilliance: BRIGHT FULL HAZY-QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT /STARBOARDAir temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE2 hours 0 minutes since slack FLOOD EBB (circle one) from tables7 hours 54 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulk-Coal</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	_____ at _____ RPM		
Length overall	<u>737</u>	(units)	<u>ft</u>
Length between perpendiculars	<u>705</u>	(units)	<u>ft</u>
Beam	<u>106</u>	(units)	<u>ft</u>
Depth	<u>58</u>	(units)	<u>ft</u>
Dead weight tonnage	<u>61,745</u>		
Gross tonnage	<u>35,800</u>		
Net tonnage	<u>31,270</u>		
Design draft	<u>41</u>	(units)	<u>ft</u>
Actual draft	<u>19</u>	FORWARD,	<u>24</u> AFT (units) <u>ft</u>
Height of eye	<u>90</u>	(units)	<u>ft</u>
Bridge to bow	<u>611</u>	(units)	<u>ft</u>
Bridge to stern	<u>125</u>	(units)	<u>ft</u>
Antenna to ship centerline	<u>0</u>	feet PORT STARBOARD (circle one)	(circle one)
	<u>0</u>	feet AFT of bridge bulkhead	

	(rpm)	(knots)
DEAD SLOW	_____	_____
SLOW	_____	_____
HALF	_____	_____
FULL MANEUVERING	_____	_____
FULL NAVIGATION	_____	_____

NOT NOTED

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data _____ MEAN DRAFT (units) _____, _____ RPM

NOT NOTED

_____ ADVANCE, _____ TRANSFER (units) _____, _____ minutes _____ seconds

Crash stop to dead in water, _____ DISTANCE (units) _____, _____ minutes _____ seconds

TRANSIT EVENTS
(local time)

IF INBOUND



at Bay Bridge mark
 Ship centerline _____ feet EAST WEST (circle one) of mark
15:1905 on green range
15:0500 on red range
14:2100 abeam Baltimore Light
14:2100 abeam 7 Foot Knoll
14:2100 abeam "4B"

IF OUTBOUND



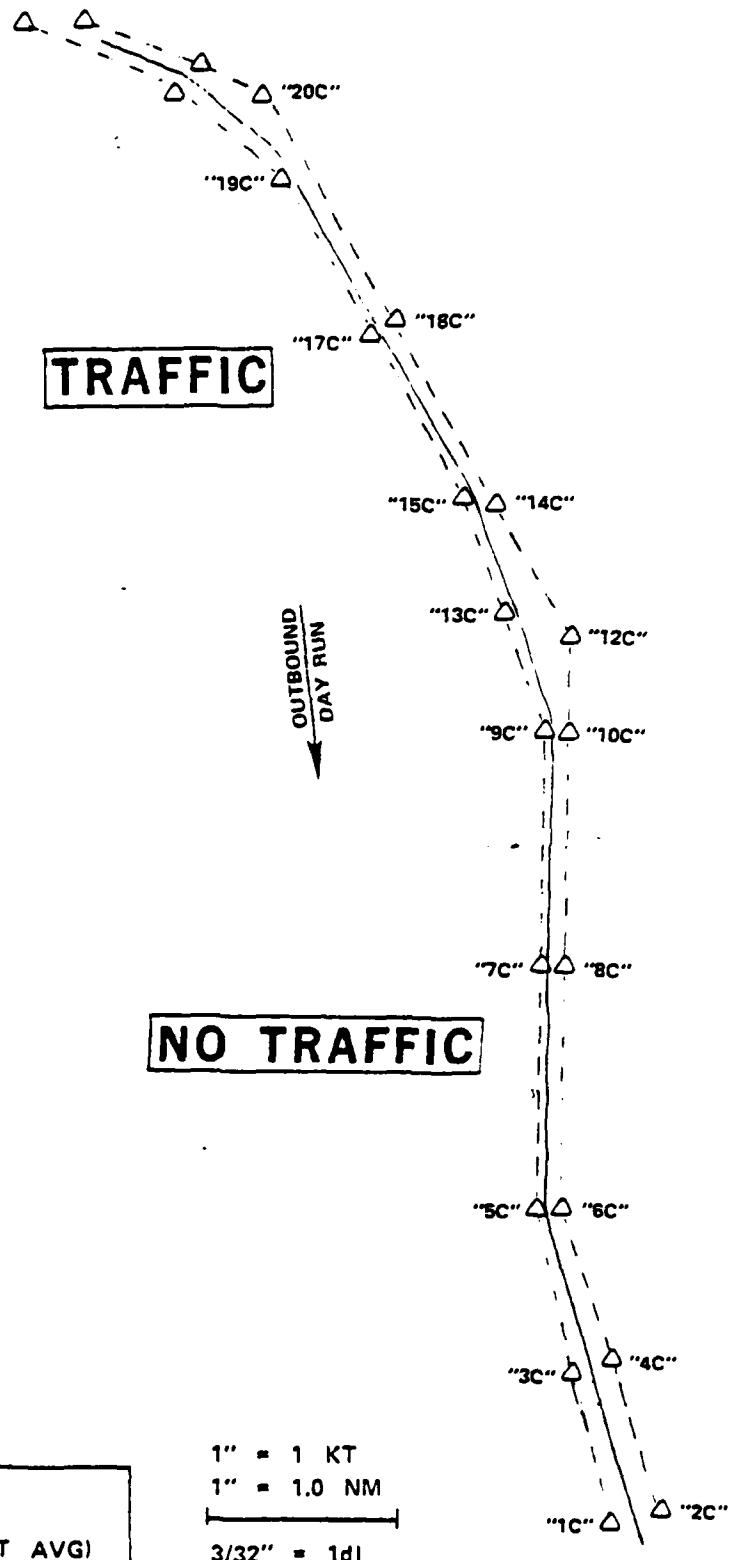
Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>110</u>	14:3430	Abeam #17 & #18
	RPM at start <u>12Kts</u>	3700	Tug ab am on stbd side
	abeam "1C"	3855	RR10
14:2303	RR10	3930	RR05
2350	MS	3950	MS
2400	RL10	4000	CC160
2412	MS	4620	RR10
2420	CC127	4630	RR20
2630	RR10	4650	RR10
2730	RR05	4720	MS
2740	MS	4730	RL10
2750	RL10	4740	MS
2815	MS	4750	CC179
2820	CC149	5300	CC178
2830	CC148	15:0110	RL10
2900	Overtaking tug 1000 yds ahead on stbd side	0200	MS

Local Time	Event	Local Time	Event
15:0230	CC162		
—	Pilot calculated speed of 12.2Kts		
1740	RR20		
1805	RR10		
1825	RR05		
1850	MS		
2032	CC194		

TAPE IN ENVELOPE?

* USCG initial _____



RUN 3

BULKER: 62 K, 705 LOA

WIND: 5 KTS

CURRENT: FLOOD (0.6 KT AVG)

1" = 1 KT

1" = 1.0 NM

3/32" = 1d

SHIP TRACKING REPORT

RUN CONDITION
(circle one)

Direction: INBOUND OUTBOUND

Time: DAY NIGHT

Method: VISUAL RADAR PATH RACON

INITIAL ENVIRONMENT
(circle one)

Weather: STABLE IMPROVING DETERIORATING

Sky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCAST

Precipitation: NONE DRIZZLE RAIN SNOW FOG

Visibility: 1/2 nm 1 nm 3 nm ≥ 5 nm

Sun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE NEW

Sun-moon direction: FORWARD AFT PORT /STARBOARD

Air temperature (F): 30 30-50 51-70 70

Sea temperature (F): 30 30-50 51-70 70

True wind direction: N NE E SE S SW W NW

True wind speed: 3 3-10 11-20 21-30 30

Sea state: CALM SLIGHT SMALL MEDIUM LARGE

.5 hours 36 minutes since slack FLOOD EBB (circle one) from tables

9 hours 28 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulk-Coal</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>16,100</u>	at _____ RPM	
Length overall	<u>699</u>	(units) <u>ft</u>	
Length between perpendiculars	<u>657</u>	(units) <u>ft</u>	
Beam	<u>95</u>	(units) <u>ft</u>	
Depth		(units)	
Dead weight tonnage	<u>50,356</u>		
Gross tonnage	<u>27,587</u>		
Net tonnage	<u>16,438</u>		
Design draft		(units)	
Actual draft	<u>5.6</u>	FORWARD, <u>6.6</u> AFT (units) <u>meters</u>	
Height of eye	<u>72</u>	(units) <u>ft</u>	
Bridge to bow		(units)	
Bridge to stern		(units)	
Antenna to ship centerline	<u>none</u>	feet PORT STARBOARD (circle one)	
	<u>none</u>	feet AFT of bridge bulkhead	

	(rpm)	(knots)
DEAD SLOW	<u>40</u>	<u>5.6</u>
SLOW	<u>60</u>	<u>8.4</u>
HALF	<u>70/75</u>	<u>9.8/10.5</u>
FULL MANEUVERING	<u>80/85</u>	<u>11.2/11.9</u>
FULL NAVIGATION		

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

NOT NOTED

ADVANCE, **TRANSFER (units)** , **minutes** **seconds**

Crash stop to dead in water, _____ DISTANCE (units) _____, minutes _____ seconds _____

TRANSIT EVENTS
(local time)

IF INBOUND



_____ at Bay Bridge mark
 Ship centerline _____ feet EAST WEST (circle one) of mark
 _____ on green range
 _____ on red range
 _____ abeam Baltimore Light
 _____ abeam 7 Foot Knoll
 _____ abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start 343	16:5940	CC308
	RPM at start 80	17:0125	RL15
	abeam "1C"	0220	CC295
16:1815	RR10	0240	CC292
1830	RR15		
1845	CC000		
2010	CC001		
2400	CC000		
2910	CC001		
3615	CC343		
3720	RR20		
4350	CC330		
4730	CC331		
5615	RL10		
5645	MS		
5910	RR10		

RUN 4

Bulker: 50K, 657 LOA
Wind: 5 knots
Current: Flood

(No tracking data was available for this run.)

SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm ≥ 5 nmSun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT /STARBOARDAir temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE3 hours 45 minutes since slack FLOOD EBB (circle one) from tables3 hours 12 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulk-Coal</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	_____ at _____ RPM		
Length overall	<u>805</u>	(units)	<u>ft</u>
Length between perpendiculars	<u>775</u>	(units)	<u>ft</u>
Beam	<u>105</u>	(units)	<u>ft</u>
Depth	_____ (units) _____		
Dead weight tonnage	<u>78,637</u>		
Gross tonnage	<u>42,141</u>		
Net tonnage	<u>28,187</u>		
Design draft	_____ (units) _____		
Actual draft	<u>6</u>	FORWARD, <u>7</u> AFT (units) <u>meters</u>	
Height of eye	<u>23</u>	(units)	<u>meters</u>
Bridge to bow	<u>666</u>	(units)	<u>ft</u>
Bridge to stern	<u>139</u>	(units)	<u>ft</u>
Antenna to ship centerline	<u>5</u>	feet PORT	<u>STARBOARD</u> (circle one)
	<u>0</u>	feet AFT of bridge bulkhead	

(rpm) (knots)

DEAD SLOW	_____	_____
SLOW	_____	_____
HALF	_____	_____
FULL MANEUVERING	_____	_____
FULL NAVIGATION	_____	_____

NOT NOTED

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data _____ MEAN DRAFT (units) _____, _____ RPM

_____ ADVANCE, _____ TRANSFER (units) _____, _____ minutes _____ seconds

Crash stop to dead in water, _____ DISTANCE (units) _____, _____ minutes _____ seconds

NOT NOTED

TRANSIT EVENTS
(local time)

IF INBOUND



_____ at Bay Bridge mark
 Ship centerline _____ feet EAST WEST (circle one) of mark
 _____ on green range
 _____ on red range
 10:1700 abeam Baltimore Light
 _____ abeam 7 Foot Knoll
 _____ abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start 015	10:3614	Port 20
	RPM at start 90	3643	Port 10
	abeam "1C"	3656	Port 05
09:5714	Port 10	3710	MS
5739	Port 20	3722	Stbd 10
5828	MS	3740	MS
5844	RR10	3749	CC339
5900	MS	4228	Port 10
5910	CC343	4245	Port 05
10:1657	Abeam Baltimore Light	4300	MS
1816	Port 20	4310	Stbd 05
2000	MS	4322	Stbd 10
2012	CC000	4325	Stbd 20
2356	CC001	4331	MS
3319	CC000	4343	CC330

Local Time	Event	Local Time	Event
10:5540	Port 10		
5620	MS		
5720	Stbd 05		
5727	Stbd 10		
5729	MS		
5750	CC310		
11:0101	Port 10		
0205	MS		
0211	Stbd 10		
0240	MS		
0243	CC292		
0611	Abeam 4B		

TAPE IN ENVELOPE?

* USCG initial _____

RUN 5

Bulker: 79K, 775 LOA
Wind: 15 knots
Current: Flood

(No tracking data was available for this run.)

SHIP TRACKING REPORT

RUN CONDITION

(circle one)

Direction: INBOUND **OUTBOUND**Time: **DAY** NIGHTMethod: **VISUAL** RADAR PATH RACONINITIAL ENVIRONMENT

(circle one)

Weather: **STABLE** IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR **OVERCAST**Precipitation: **NONE** DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm **≥ 5 nm**Sun-moon brilliance: BRIGHT-FULL HAZY-QUARTER **OBSCURE** NEWSun-moon direction: **FORWARD** AFT PORT /STARBOARDAir temperature (F): 30 30-50 **51-70** 70Sea temperature (F): 30 30-50 **51-70** 70True wind direction: N NE E SE S SW W **NW**True wind speed: 3 **3-10** 11-20 21-30 30Sea state: **CALM** SLIGHT SMALL MEDIUM LARGE0 hours 33 minutes since slack **FLOOD** **EBB** (circle one) from tables0 hours 48 minutes since sun **RISE** **SET** (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulk-Sugar</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>14,500</u>	at	RPM
Length overall	<u>193</u>	(units)	<u>meters</u>
Length between perpendiculars	<u>178</u>	(units)	<u>meters</u>
Beam	<u>27</u>	(units)	<u>meters</u>
Depth	<u>16</u>	(units)	<u>meters</u>
Dead weight tonnage	<u>35,339</u>		
Gross tonnage	<u>19,411</u>		
Net tonnage	<u>12,378</u>		
Design draft	(units) _____		
Actual draft	<u>29</u>	FORWARD,	<u>30</u> AFT (units) <u>ft</u>
Height of eye	<u>62</u>	(units)	<u>ft</u>
Bridge to bow	<u>495</u>	(units)	<u>ft</u>
Bridge to stern	<u>138</u>	(units)	<u>ft</u>
Antenna to ship centerline	<u>20</u>	feet PORT	<u>STARBOARD</u> (circle one)
	<u>0</u>	feet AFT of bridge bulkhead	

	(rpm)	(knots)
DEAD SLOW	<u>45</u>	<u>6</u>
SLOW	<u>55</u>	<u>8</u>
HALF	<u>80</u>	<u>12</u>
FULL MANEUVERING	<u>90</u>	<u>13</u>
FULL NAVIGATION	<u>100</u>	<u>15</u>

NOT NOTED Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

 ADVANCE, TRANSFER (units) , minutes seconds

Crash stop to dead in water, DISTANCE (units) , minutes seconds

TRANSIT EVENTS
(local time)

IF INBOUND



09:2930 at Bay Bridge mark
 Ship centerline 20 feet EAST WEST (circle one) of mark
09:2430 on green range
09:2250 on red range
09:0905 abeam Baltimore Light
08:3845 abeam 7 Foot Knoll
08:2340 abeam "4B"

IF OUTBOUND



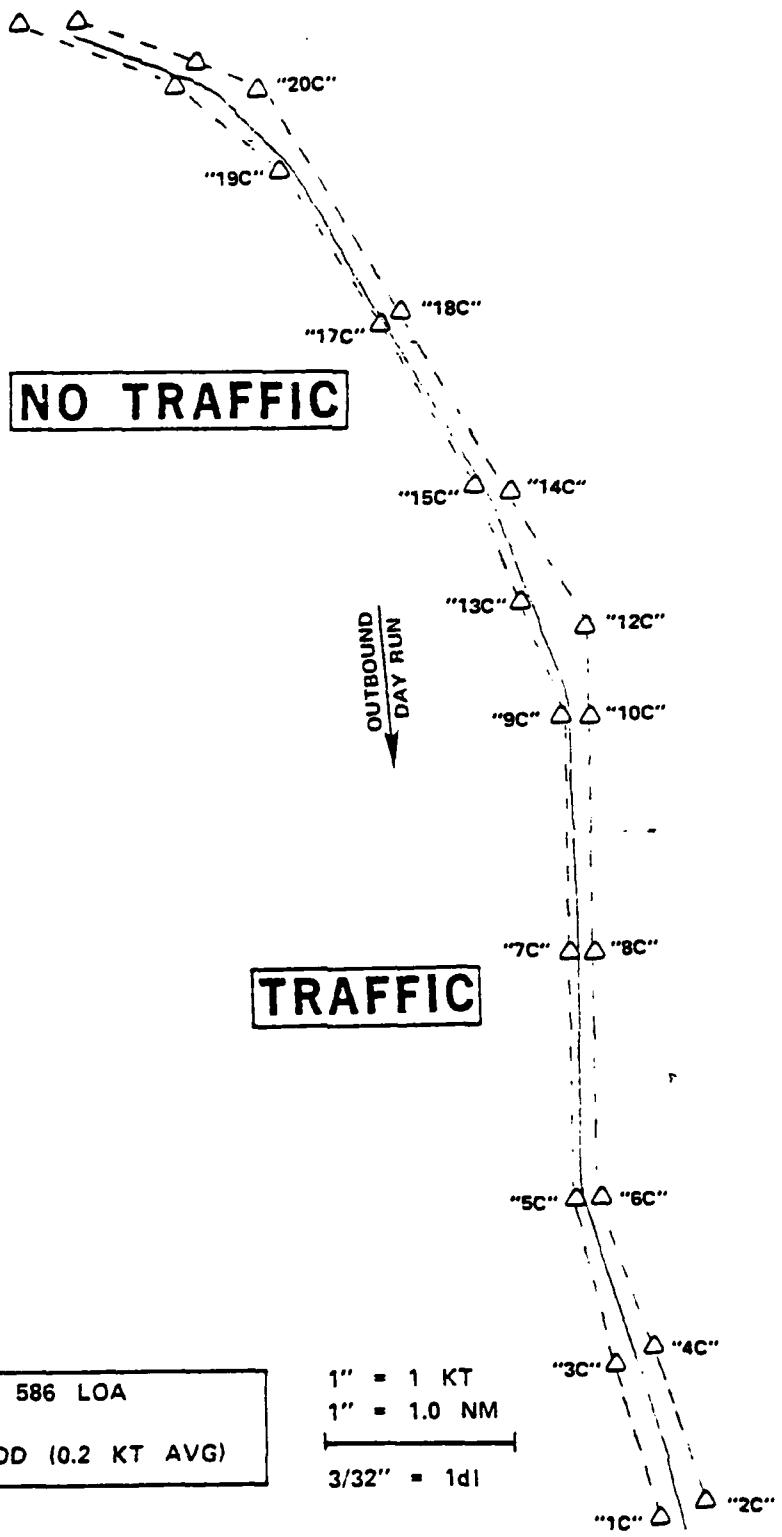
Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
08:2340	Course at start <u>110</u>	08:4340	MS
	RPM at start <u>95</u>	4345	Port 10
	abeam "1C"	4355	MS
08:2700	Stbd 10	4500	CC159
2800	MS	4920	Stbd 10
2830	Port 10	4940	Stbd 20
2900	MS	5005	Stbd 10
2910	CC134	5030	MS
3045	Stbd 20	5050	Port 10
3115	Stbd 10	5110	MS
3120	MS	5115	CC179
3125	Port 10	5245	Traffic ship on port side maneuvered to stbd
3150	MS	5330	CC176
3220	CC149	5645	CC179
3640	CC148		
4240	Stbd 10		

Local Time	Event	Local Time	Event
09:0450	Port 10		
0520	MS		
0600	Stbd 10		
0625	MS		
0640	CC161		
1315	CC165		
2250	Red range		
2430	Green range		
2930	Bridge		

TAPE IN ENVELOPE?

* USCG initial _____



SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm 5 nmSun-moon brilliance: BRIGHT FULL HAZY-QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT /STARBOARDAir temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE0 hours 04 minutes since slack FLOOD EBB (circle one) from tables2 hours 54 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPT

	(rpm)	(knots)
DEAD SLOW	<u>35</u>	<u>5</u>
SLOW	<u>45</u>	<u>6</u>
HALF	<u>70</u>	<u>9</u>
FULL MANEUVERING	<u>85</u>	<u>11</u>
FULL NAVIGATION	<u>110</u>	<u>16</u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

2096 ADVANCE, 1256 TRANSFER (units) ft 1 2 minutes 52 seconds

Crash stop to dead in water, 8000 DISTANCE (units) ft / 10 minutes 0 seconds

TRANSIT EVENTS
(local time)

IF INBOUND



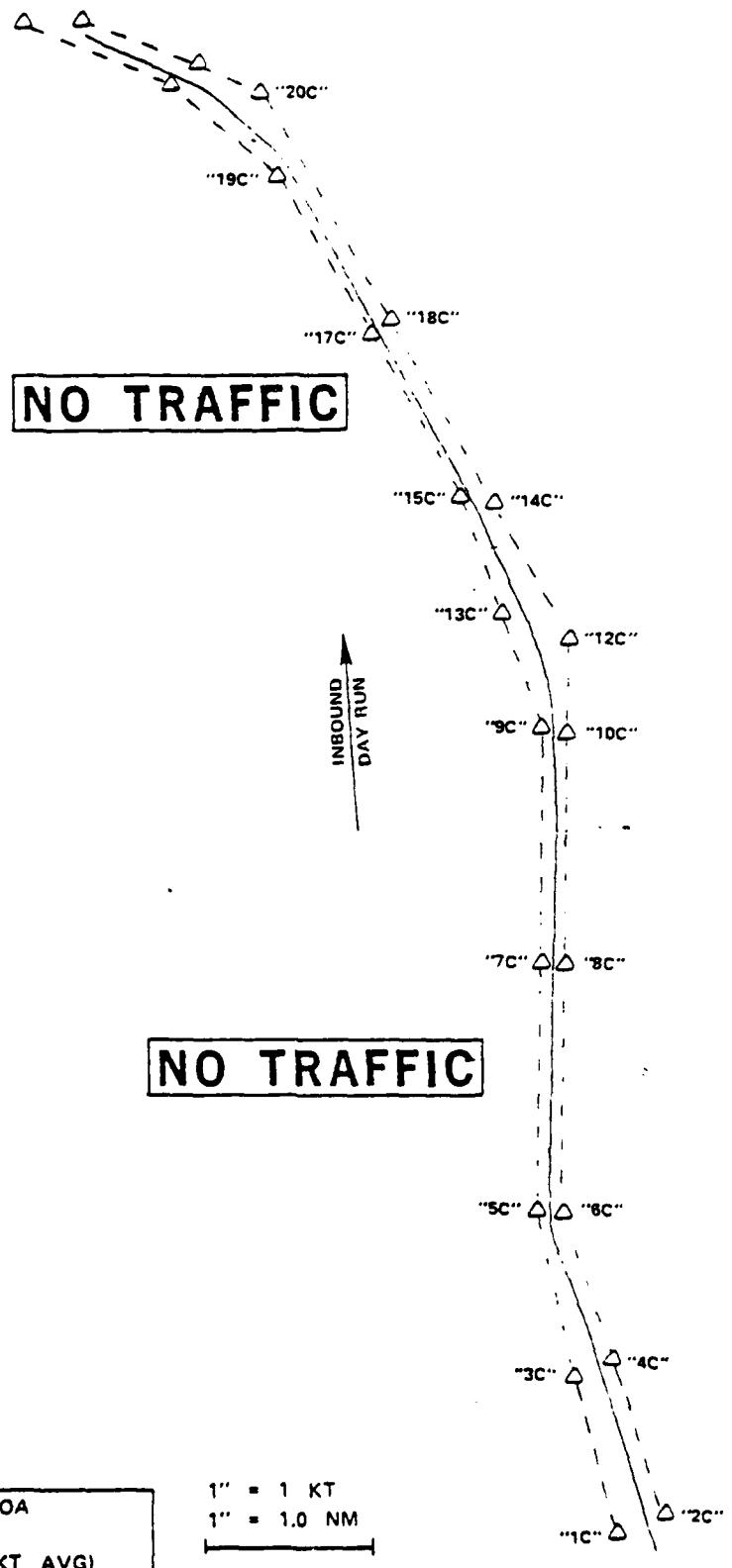
09:3410 at Bay Bridge mark
 Ship centerline 30 feet EAST WEST (circle one) of mark
09:3926 on green range
09:4125 on red range
09:5427 abeam Baltimore Light
— abeam 7 Foot Knoll
10:4330 abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>340</u>	10:1516	CC332
	RPM at start <u>105</u>	1557	CC330
09:4740	abeam "1C"	1642	CC328
09:5251	CC337	1752	CC329
5505	Stbd 10	2515	CC328
5552	MS	2639	Port 10
5645	CC358 Steering to stbd to pass container ship outbnd	2720	MS
5820	Abeam container ship	2800	CC310
10:0718	CC355	2923	Port 10
0936	CC345 Pilot believes ship on center now	3012	MS
1037	CC340	3044	CC292
1112	CC335	3142	CC291
1214	CC332	3430	Abeam "4B"
1400	CC334	3536	CC291



RUN 7
 BULKER: 63 K, 698 LOA
 WIND: 15 KTS
 CURRENT: SLACK (0 KT AVG)

1" = 1 KT
 1" = 1.0 NM
 3/32" = 1d1

SHIP TRACKING REPORT

RUN CONDITION
(circle one)

Direction: INBOUND OUTBOUND

Time: DAY NIGHT

Method: VISUAL RADAR PATH RACON

INITIAL ENVIRONMENT
(circle one)

Weather: STABLE IMPROVING DETERIORATING

Sky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCAST

Precipitation: NONE DRIZZLE RAIN SNOW FOG

Visibility: 1/2 nm 1 nm 3 nm ≥ 5 nm

Sun-moon brilliance: BRIGHT FULL HAZY-QUARTER OBSCURE-NEW

Sun-moon direction: FORWARD AFT PORT STARBOARD

Air temperature (F): 30 30-50 51-70 70

Sea temperature (F): 30 30-50 51-70 70

True wind direction: N NE E SE S SW W NW

True wind speed: 3 3-10 11-20 21-30 30

Sea state: CALM SLIGHT SMALL MEDIUM LARGE

1 hours 13 minutes since slack FLOOD EBB (circle one) from tables

1 hours 14 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Oil-Tanker</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>11,600</u>	at	<u>124</u> RPM
Length overall	<u>602</u>	(units)	<u>ft</u>
Length between perpendiculars	<u>565</u>	(units)	<u>ft</u>
Beam	<u>85</u>	(units)	<u>ft</u>
Depth	<u>47</u>	(units)	<u>ft</u>
Dead weight tonnage	<u>30,698</u>		
Gross tonnage	<u>20,703</u>		
Net tonnage	<u>16,363</u>		
Design draft	(units) _____		
Actual draft	<u>32</u>	FORWARD, <u>33</u> AFT (units) <u>ft</u>	→
Height of eye	<u>18.4</u>	(units)	<u>meters</u>
Bridge to bow	<u>475</u>	(units)	<u>ft</u>
Bridge to stern	<u>127</u>	(units)	<u>ft</u>
Antenna to ship centerline	<u>20</u>	feet PCRT	<u>STARBOARD</u>
	<u>20</u>	feet AFT of bridge bulkhead	(circle one)

	(rpm)	(knots)
DEAD SLOW	<u>40</u>	<u>6</u>
SLOW	<u>60</u>	<u>9</u>
HALF	<u>75</u>	<u>11</u>
FULL MANEUVERING	<u>90</u>	<u>14</u>
FULL NAVIGATION	<u>120</u>	<u>18</u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) 105 RPM Full loaded

.3 ADVANCE, .18 TRANSFER (units) nm, 9 minutes 30 seconds

Crash stop to dead in water, .55 DISTANCE (units) nm, 14 minutes 10 seconds

TRANSIT EVENTS
(local time)

IF INBOUND



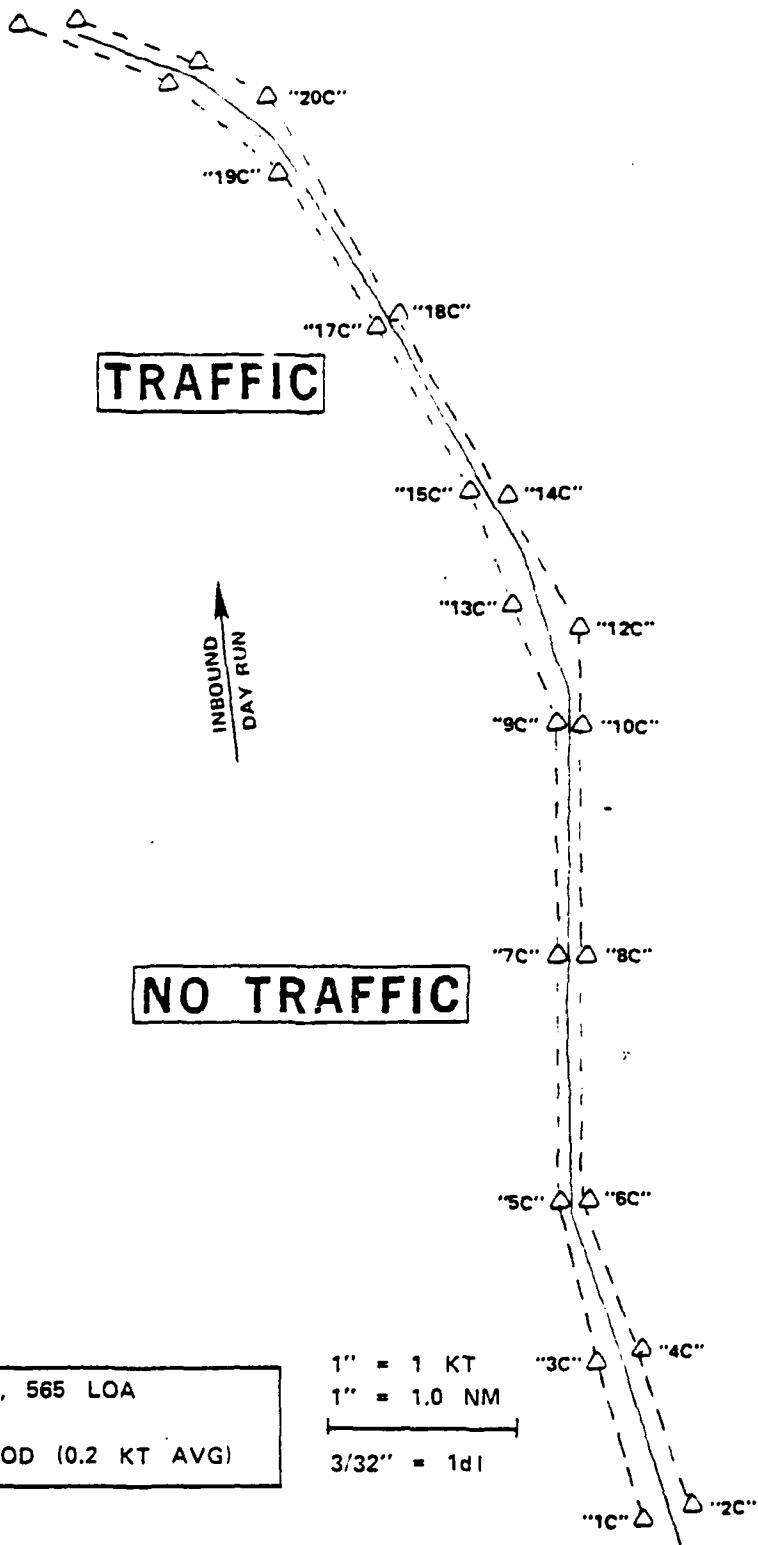
08:0815 at Bay Bridge mark
 Ship centerline 30 feet EAST WEST (circle one) of mark
08:1343 on green range
08:1550 on red range
08:2944 abeam Baltimore Light
08:5950 abeam 7 Foot Knoll
09:1454 abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>344</u>	08:5228	MS
	RPM at start <u>85</u>	5245	CC330
	abeam "1C"	5710	CC332 Moving Right for outbnd traffic - 1 whistle
08:2400	Steering to right of center overtaking tug/barge		Abeam outbnd traffic
2600	Abeam tug/barge	09:0108	CC329
2935	CC342	0628	Port 10
3055	Stbd 10	0656	MS
3145	MS	0745	CC310
3210	CC000	0820	CC308
3718	CC002	0940	Port 10
4702	Port 10	1038	MS
4742	MS	1040	CC290
4807	CC343	1124	CC291
5152	Port 10	1454	Abeam "4B"



RUN 8

TANKER: 31 K, 565 LOA
WIND: 5 KTS
CURRENT: FLOOD (0.2 KT AVG)

SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm ≥ 5 nmSun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT /STARBOARDAir temperature (F): 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE0 hours 02 minutes since slack FLOOD EBB (circle one) from tables12 hours 01 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulk-Coal</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>14,000</u>	at	<u>122</u> RPM
Length overall	<u>682</u>	(units)	<u>ft</u>
Length between perpendiculars	<u>646</u>	(units)	<u>ft</u>
Beam	<u>105</u>	(units)	<u>ft</u>
Depth	<u>58</u>	(units)	<u>ft</u>
Dead weight tonnage	<u>50,864</u>		
Gross tonnage	<u>29,148</u>		
Net tonnage	<u>19,608</u>		
Design draft	(units) _____		
Actual draft	<u>29</u>	FORWARD, <u>29</u>	AFT (units) <u>ft</u>
Height of eye	<u>72</u>	(units)	<u>ft</u>
Bridge to bow	<u>552</u>	(units)	<u>ft</u>
Bridge to stern	<u>130</u>	(units)	<u>ft</u>
Antenna to ship centerline	<u>5</u>	feet	<u>PORT</u> STARBOARD (circle one)
	<u>0</u>	feet AFT of bridge bulkhead	

	(rpm)	(knots)
DEAD SLOW	<u>25</u>	<u>3.2</u>
SLOW	<u>50</u>	<u>6.4</u>
HALF	<u>70</u>	<u>8.8</u>
FULL MANEUVERING	<u>95</u>	<u>12.1</u>
FULL NAVIGATION	<u>120</u>	<u>15.4</u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , 106 RPM 23,892 DISPLACEMENT TONS

750 ADVANCE, 260 TRANSFER (units) meters 2 minutes 15 seconds

Crash stop to dead in water, 1,952 DISTANCE (units) meters 9 minutes 20 seconds

TRANSIT EVENTS

(local time)

IF INBOUND



04:5000 at Bay Bridge mark
 Ship centerline 55 feet EAST WEST (circle one) of mark
 04:5842 on green range
 — on red range
 — abeam Baltimore Light
 — abeam 7 Foot Knoll
 05:0942 abeam "4B"

IF OUTBOUND



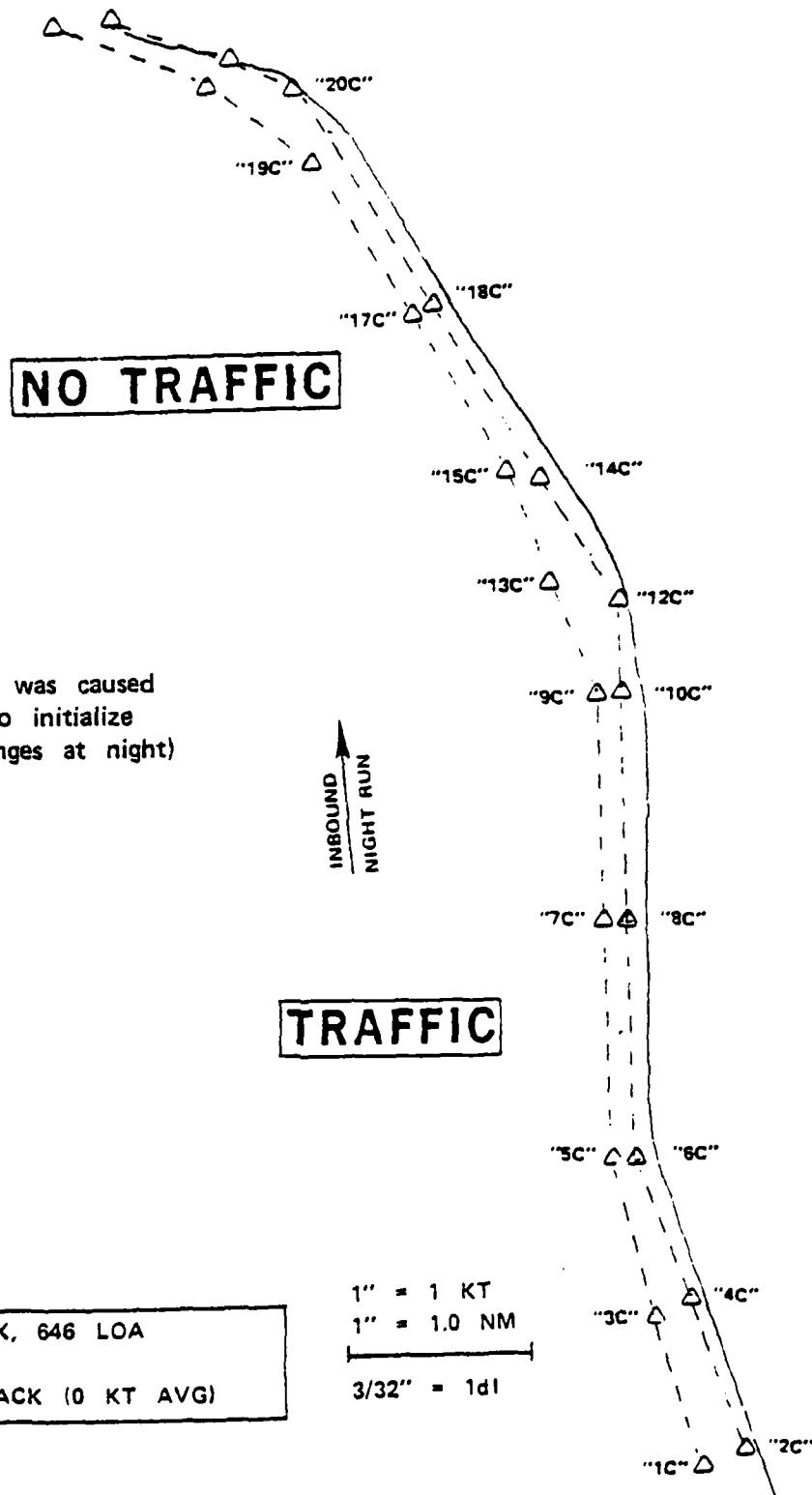
Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>340</u>	05:2132	CC358
	RPM at start <u>100</u>	2312	CC000
<u>05:0833</u>	abeam "1C" Traffic vessel astern overtaking		Maneuvering for overtaking vessel
1831	Stbd 15	2519	CC358
1853	Stbd 10		Tug outbnd outside the channel won't effect O.S.
1902	MS	2802	" Stbd 10
1910	Port 10	2810	CC000
1932	MS	3130	Abeam outbnd tug/barges to port side
1940	Stbd 10	3219	CC358
1950	MS	3440	Abeam container ship overtaking O.S. on port side
2050	Port 10		
2100	MS	3446	MS
2126	Stbd 10	3500	Port 15

Local Time	Event	Local Time	Event
05:5509	MS	05:5911	Port 10
3514	Stbd 10	5932	MS Abeam CG Cutter outside channel to port side
3538	MS		
3600	Stbd 10	06:0038	Stbd 10
3609	MS	0104	MS
3620	Port 10	0111	CC310
3629	MS	0240	Port 10
3635	Stbd 10	0259	MS
3556	MS	0350	Stbd 10
3730	Stbd 15	0359	MS
3745	MS	0410	Port 10
3800	Port 10	0418	MS
3825	MS	0442	Stbd 10
3935	Stbd 10	0459	Stbd 15
3944	MS	0508	MS
4048	Stbd 10	0520	CC290
4048	MS	0845	CC292
4215	Stbd 10	0942	Abeam "4B"
4230	MS		
4236	CC328		
4348	CC326 Pilot tending to keep to stbd side of channel since being overtaken		
5000	CC328		
5243	CC330 Inbnd traffic crossing to stbd has to fall ahead of O.S.		

TAPE IN ENVELOPE?

* USCG initial _____



SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm ≥ 5 nmSun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT STARBOARDAir temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE3 hours 00 minutes since slack FLOOD EBB (circle one) from tables1 hours 37 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulk-Coal</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>16,800</u>	at	RPM
Length overall	<u>817</u>	(units)	<u>ft</u>
Length between perpendiculars	<u>793</u>	(units)	<u>ft</u>
Beam	<u>106</u>	(units)	<u>ft</u>
Depth	<u>64</u>	(units)	<u>ft</u>
Dead weight tonnage	<u>30,373</u>		
Gross tonnage	<u>42,724</u>		
Net tonnage	<u>30,918</u>		
Design draft	(units)		
Actual draft	<u>23</u>	FORWARD, <u>23</u>	AFT (units) <u>ft</u>
Height of eye	<u>92</u>	(units)	<u>ft</u>
Bridge to bow	<u>698</u>	(units)	<u>ft</u>
Bridge to stern	<u>120</u>	(units)	<u>ft</u>
Antenna to ship centerline	<u>15</u>	feet	<u>P</u> ORT STARBOARD (circle one)
	<u>5</u>	feet AFT of bridge bulkhead	

	(rpm)	(knots)
DEAD SLOW	<u>35</u>	<u>5.3</u>
SLOW	<u>50</u>	<u>7.4</u>
HALF	<u>70</u>	<u>10.4</u>
FULL MANEUVERING	<u>90</u>	<u>13.4</u>
FULL NAVIGATION	<u>102</u>	<u>14.6</u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data 47 MEAN DRAFT (units) ft, 102 RPM

.51 ADVANCE, .51 TRANSFER (units) nm, 6 minutes 35 seconds

Crash stop to dead in water, 1.6 DISTANCE (units) nm, 7 minutes 51 seconds

TRANSIT EVENTS
(local time)

IF INBOUND



08:5549 at Bay Bridge mark
 Ship centerline 50 feet EAST WEST (circle one) of mark
 — on green range
 — on red range
 — abeam Baltimore Light
 — abeam 7 Foot Knoll
 — abeam "4B"
09:4244

IF OUTBOUND



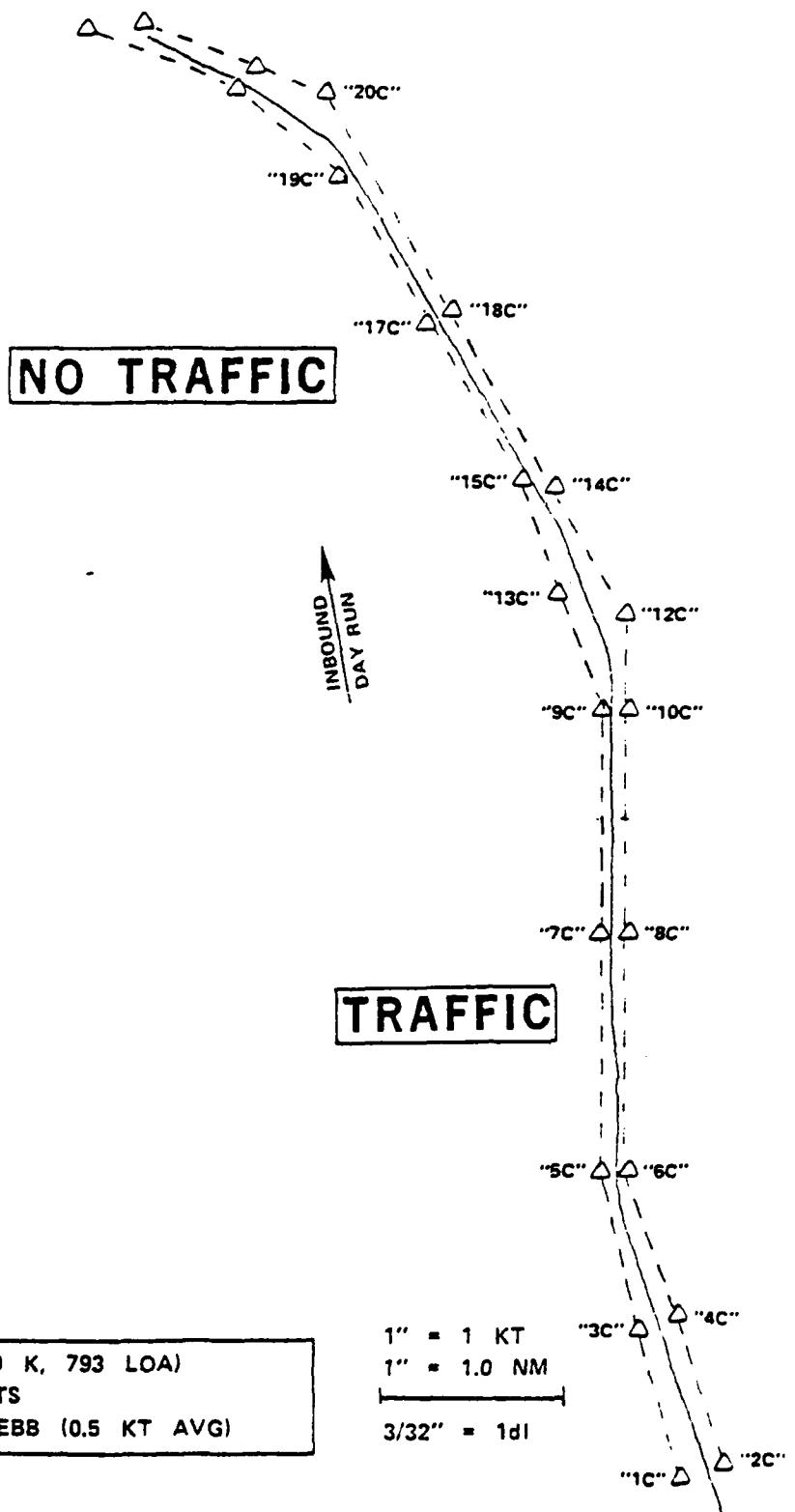
Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
<u>08:5546</u>	Course at start <u>342</u> RPM at start <u>95</u> abeam "1C"	0900	CC000
09:0215	Stbd 05	0910	Pilot estimates in centerline
0226	Stbd 10	1739	Port 10
0240	Stbd 05	1818	Port 05
0344	MS	1838	MS
0407	Port 05	1914	Stbd 05
0415	MS - Traffic vessel outbnd	1938	Half ahead - slowing for tug/barge
0530	Stbd 15	1940	MS
0618	Stbd 10	2000	CC339
0640	MS - Abeam Coal Carrier	2202	Port 05
0646	CC357	2257	MS - Moving right to pass outbnd tug/barge
0804	CC358	2315	Stbd 05
0840	CC359	2328	Stbd 10
		2420	Full ahead

Local Time	Event	Local Time	Event
09:2430	Abeam outbnd tug/barge to port side		
2511	CC331		
3522	Port 10		
3547	Port 05		
3647	MS		
3655	Stbd 05		
3705	Stbd 10		
3718	MS		
3757	CC303		
3834	Port 10		
3903	Port 05		
3923	MS		
3929	Stbd 05		
4015	CC292		
4244	Abeam "4B"		

TAPE IN ENVELOPE?

* USCG initial _____



SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm 5 nmSun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT /STARBOARDAir temperature (F): < 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE0 hours 26 minutes since slack FLOOD EBB (circle one) from tables12 hours 21 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	Container	
Propulsion	Steam Turbine	
Shaft horsepower	18,500	at _____ RPM
Length overall	610	(units) ft
Length between perpendiculars	(units) _____	
Beam	78	(units) ft
Depth	(units) _____	
Dead weight tonnage	16,205	
Gross tonnage	17,902	
Net tonnage	_____	
Design draft	31	(units) ft
Actual draft	26	FORWARD, _____ AFT (units) _____
Height of eye	unknown	(units) _____
Bridge to bow	87	(units) ft
Bridge to stern	523	(units) ft
Antenna to ship centerline	5	feet PORT STARBOARD (circle one)
	0	feet AFT of bridge bulkhead

	(rpm)	(knots)
DEAD SLOW	10	2.6
SLOW	20	4.8
HALF	40	8.6
FULL MANEUVERING	60	10.4
FULL NAVIGATION	_____	_____

NOT NOTED Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data _____ MEAN DRAFT (units) _____, _____ RPM

_____ ADVANCE, _____ TRANSFER (units) _____, _____ minutes _____ seconds

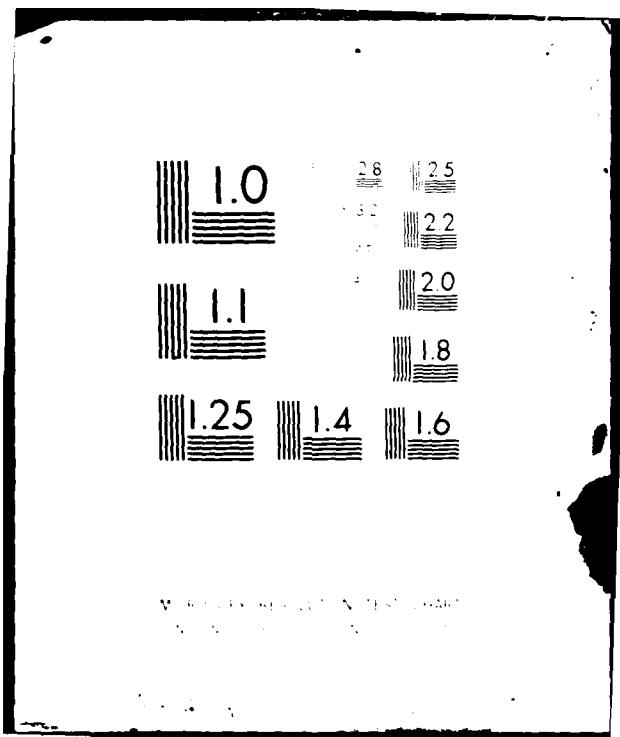
Crash stop to dead in water, _____ DISTANCE (units) _____, _____ minutes _____ seconds

AD-A111 978

ECLECTECH ASSOCIATES INC NORTH STONINGTON CT F/6 17/7
AT-SEA DATA COLLECTION FOR THE VALIDATION OF PILOTING SIMULATIO--ETC(IU)
DEC 81 R B COOPER, R C COOK, K L MARINO DOT-CG-835285-A
UNCLASSIFIED EA-81-U-078 USC6-D-60-81 NL

2 OF 2
404
11-27-86

END
DATE
FILED
104-82
DTIC



TRANSIT EVENTS
(local time)

IF INBOUND



05:0500 at Bay Bridge mark
 Ship centerline 20 feet EAST WEST (circle one) of mark
— on green range
— on red range
05:2400 abeam Baltimore Light
05:5000 abeam 7 Foot Knoll
06:0400 abeam "4B"

IF OUTBOUND

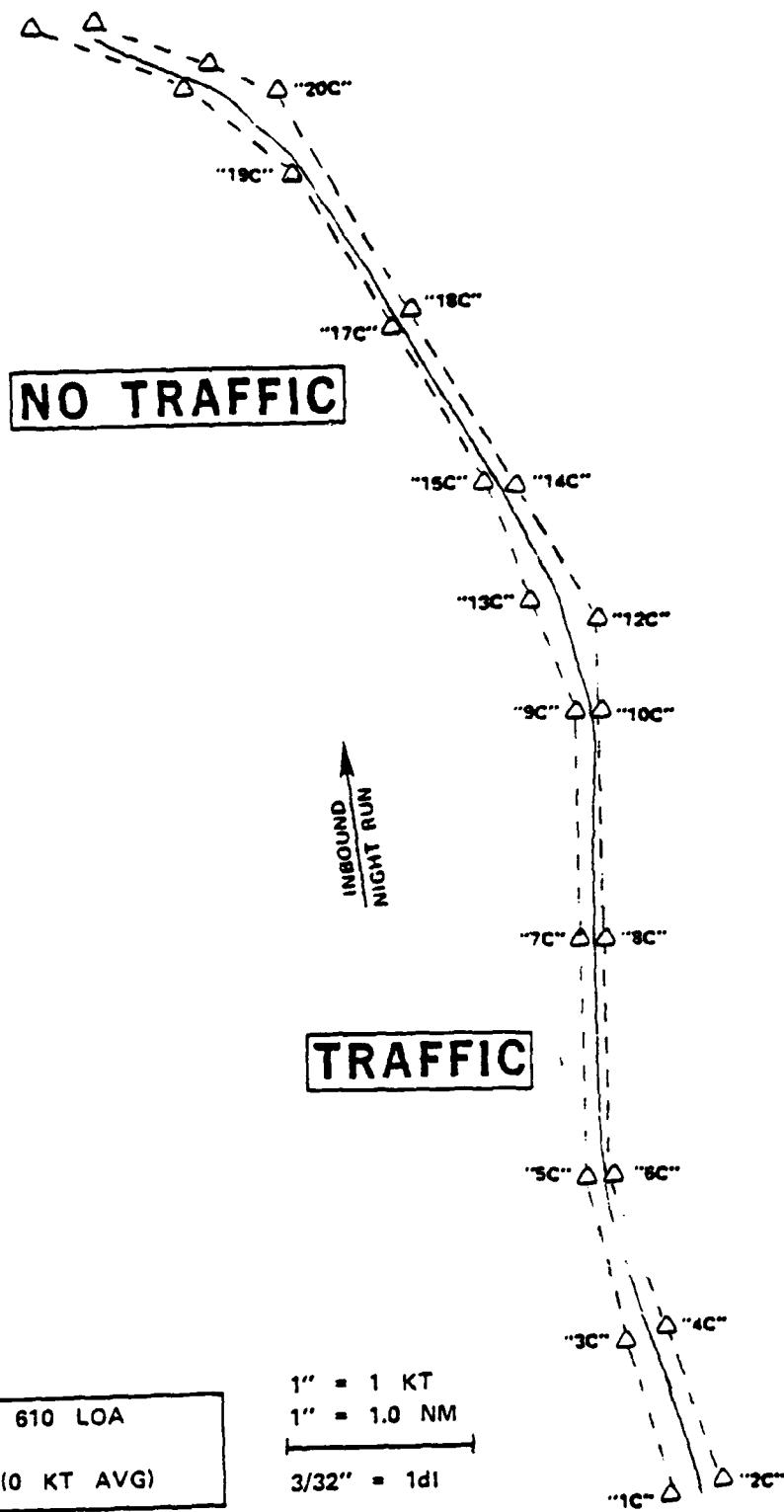


Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>347</u>	05:3819	CC000
	RPM at start <u>60</u>	3910	MS
<u>05:1800</u>	abeam "1C"	3950	Abeam traffic ship
05:1910	CC345	4012	CC344
1956	CC342	4311	RL10
2306	CC344	4335	CC333
2546	RR10	4625	CC330
2607	RR05	4755	CC328
2620	MS	4954	CC330
2629	CC356	5317	CC328
2730	CC358	5704	RL10
2918	CC000	5727	CC312
3759	CC002 Keeping to right to pass outbnd traffic ship port side	5947	RL10

TAPE IN ENVELOPE?

* USCG initial _____



RUN 11

CONTAINER: 16 K, 610 LOA
WIND: 20 KTS
CURRENT: SLACK (0 KT AVG)

SHIP TRACKING REPORT

RUN CONDITION
(circle one)

Direction: INBOUND OUTBOUND

Time: DAY NIGHT

Method: VISUAL RADAR PATH RACON

INITIAL ENVIRONMENT
(circle one)

Weather: STABLE IMPROVING DETERIORATING

Sky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCAST

Precipitation: NONE DRIZZLE RAIN SNOW FOG

Visibility: 1/2 nm 1 nm 3 nm ≥ 5 nm

Sun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE-NEW

Sun-moon direction: FORWARD AFT PORT /STARBOARD

Air temperature (F): 30 30-50 51-70 70

Sea temperature (F): 30 30-50 51-70 70

True wind direction: N NE E SE S SW W NW

True wind speed: 3 3-10 11-20 21-30 30

Sea state: CALM SLIGHT SMALL MEDIUM LARGE

1 hours 29 minutes since slack FLOOD EBB (circle one) from tables

6 hours 15 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulker</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>18,400</u>	at <u>122</u>	RPM
Length overall	<u>833.79</u>	-	(units) <u>ft</u>
Length between perpendiculars	<u>800.52</u>	-	(units) <u>ft</u>
Beam	<u>105.64</u>	-	(units) <u>ft</u>
Depth	<u>57.74</u>	-	(units) <u>ft</u>
Dead weight tonnage	<u>69,689 summer/67,816 winter</u>		
Gross tonnage	<u>35,723</u>		
Net tonnage	<u>26,402</u>		
Design draft	(units)		
Actual draft	<u>9</u>	FORWARD,	<u>24</u> AFT (units) <u>ft</u>
Height of eye	<u>75</u>	-	(units) <u>ft</u>
Bridge to bow	<u>685</u>	-	(units) <u>ft</u>
Bridge to stern	<u>148</u>	-	(units) <u>ft</u>
Antenna to ship centerline	<u>4</u>	feet P ORT STARBOARD (circle one)	(circle one)
	<u>0</u>	feet AFT of bridge bulkhead	

	(rpm)	(knots)
DEAD SLOW	<u>30</u>	<u>4.6</u>
SLOW	<u>45</u>	<u>7.6</u>
HALF	<u>65</u>	<u>9.4</u>
FULL MANEUVERING	<u>80</u>	<u>11.4</u>
FULL NAVIGATION	<u>122</u>	<u>16</u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

 875 ADVANCE, 450 TRANSFER (units) meters minutes seconds

Crash stop to dead in water, DISTANCE (units) , minutes seconds

TRANSIT EVENTS
(local time)

IF INBOUND



13:3416 at Bay Bridge mark
 Ship centerline 100 feet EAST WEST (circle one) of mark
13:3900 on green range
13:4100 on red range
13:5300 abeam Baltimore Light
14:2000 abeam 7 Foot Knoll
— abeam "4B"

IF OUTBOUND



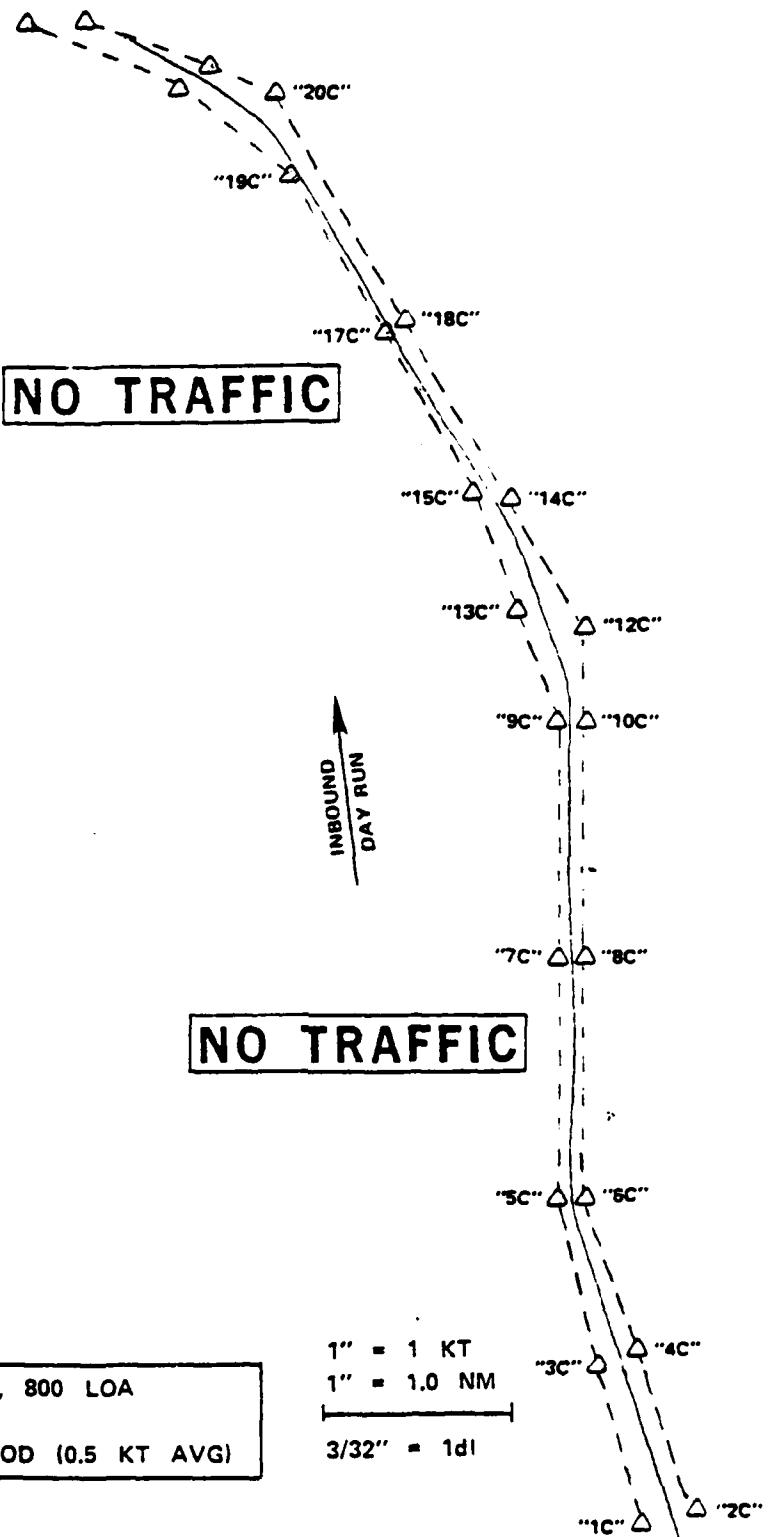
Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>344</u>	14:0925	MS
	RPM at start <u>90</u>	1005	Stbd 10
	abeam "1C"	1022	MS
13:5425	Stbd 10	1030	Stdy 342
5525	MS	1330	Port 10
5535	Stbd 10	1406	MS
5604	MS - Aligned to Stbd side of channel	1414	Stbd 10
5653	Stbd 05	1453	MS
5703	MS	1500	Stdy 330
5711	Stdy 004	1714	Stdy 331
5720	MS	1902	Stdy 332
14:0000	Passing Car carrier	2540	Port 10
0030	Stdy 001 crossing to C _L	2640	MS
0435	Port 10	2708	Stbd 10

Local Time	Event	Local Time	Event
14:2720	MS		
2856	Port 10		
2915	MS		
2920	Stbd 10		
3000	MS		
3015	Stdy 292		
3220	Stdy 293		

TAPE IN ENVELOPE?

* USCG initial _____



SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm 5 nmSun-moon brilliance: BRIGHT-FULL HAZY QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT /STARBOARDAir temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE4 hours 36 minutes since slack FLOOD EBB (circle one) from tables4 hours 06 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulker</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u> </u> at <u> </u> RPM		
Length overall	<u>800</u>	(units)	<u>ft</u>
Length between perpendiculars	<u>786</u>	(units)	<u>ft</u>
Beam	<u>106</u>	(units)	<u>ft</u>
Depth	<u>60</u>	(units)	<u>ft</u>
Dead weight tonnage	<u>68,785</u>		
Gross tonnage	<u>35,625</u>		
Net tonnage	<u>29,947</u>		
Design draft	<u>41 ft 5 in</u> (units) <u> </u>		
Actual draft	<u>23</u>	FORWARD, <u>29</u> AFT (units) <u> </u> ft	
Height of eye	<u> </u> (units) <u> </u>		
Bridge to bow	<u> </u> (units) <u> </u>		
Bridge to stern	<u> </u> (units) <u> </u>		
Antenna to ship centerline	<u> </u> feet PORT STARBOARD (circle one) <u> </u> feet AFT of bridge bulkhead		

	(rpm)	(knots)
DEAD SLOW	<u>40</u>	<u>4.69</u>
SLOW	<u>50</u>	<u>6.08</u>
HALF	<u>60</u>	<u>7.39</u>
FULL MANEUVERING	<u>85</u>	<u>11.14</u>
FULL NAVIGATION	<u> </u>	<u> </u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

1200 ADVANCE, TRANSFER (units) nm, 5 minutes seconds

Crash stop to dead in water, 3200 DISTANCE (units) nm, 13 minutes seconds

TRANSIT EVENTS
(local time)

IF INBOUND



at Bay Bridge mark
Ship centerline 100 feet EAST WEST (circle one) of mark

11:2135 on green range
11:2410 on red range
11:3936 abeam Baltimore Light
12:1153 abeam 7 Foot Knoll
12:2729 abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

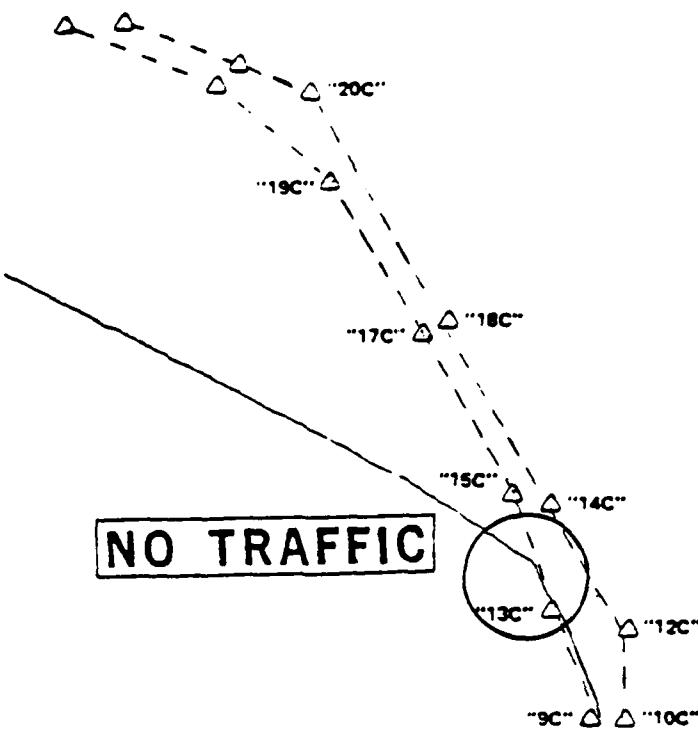
Local Time	Event	Local Time	Event
	Course at start <u>337</u>	11:5840	Port 05
<u>11:3156</u>	RPM at start <u>85</u>	5850	MS
	abeam "1C"	5982	Stbd 20
11:3400	Stbd 10 Stdy 341 - Should be close to CL	5925	Stbd 10
3500	Stdy 342	5930	Stbd 05
4050	Stbd 15	5939	Stbd 10
4120	Stbd 05	5947	Stbd 20
4129	MS	12:0002	Stdy 337
4205	Port 20	0527	Port 10
4223	MS	0555	Port 05
4235	Stbd 10	0602	MS
4245	MS	0620	Stbd 20
4256	Port 10	0630	Hard stbd
4304	MS	0640	MS
4310	Stdy 359	0648	Port 15

Local Time	Event	Local Time	Event
12:0704	MS		
0715	Std y 328		
1600	Std y 329		
1830	Port 15		
1919	MS		
1955	Stbd 20		
2005	Stbd 25		
2025	Stbd 10		
2030	MS		
2040	Std y 303		
2240	Port 15		
2313	Port 05		
2334	MS		
2350	Stbd 15		
2400	Stbd 20		
2405	Stbd 05		
2412	MS - Std y 290		

TAPE IN ENVELOPE?



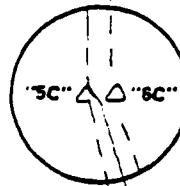
USCG initial _____



(Tracking error was caused
by raydist printer malfunction
or loss of tracking on one
L.O.P.)

INBOUND
DAY RUN

NO TRAFFIC



RUN 13

BULKER: 69 K, 786 LOA
WIND: 5 KTS
CURRENT: EBB (0.4 KT AVG)

1" = 1 KT
1" = 1.0 NM
3/32" = 1 dI

SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm ≥ 5 nmSun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE-NEW

Sun-moon direction: FORWARD AFT PORT /STARBOARD

Air temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE3 hours 20 minutes since slack FLOOD EBB (circle one) from tables0 hours 29 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulker</u>		
Propulsion	<u> </u>		
Shaft horsepower	<u>23,300</u>	at <u>114</u>	RPM
Length overall	<u>865</u>	-	(units) <u>ft</u>
Length between perpendiculars	<u>823</u>	-	(units) <u>ft</u>
Beam	<u>133</u>	-	(units) <u>ft</u>
Depth	<u>71</u>	-	(units) <u>ft</u>
Dead weight tonnage	<u>116,190</u>		
Gross tonnage	<u>53,520</u>		
Net tonnage	<u>41,798</u>		
Design draft	<u> </u> (units) <u> </u>		
Actual draft	<u>22</u>	FORWARD, <u>26</u>	AFT (units) <u>ft</u>
Height of eye	<u>111</u>	-	(units) <u>ft</u>
Bridge to bow	<u>717</u>	-	(units) <u>ft</u>
Bridge to stern	<u>148</u>	-	(units) <u>ft</u>
Antenna to ship centerline	<u>21</u>	feet <u>PORT</u>	STARBOARD (circle one)
	<u>21</u>	feet AFT of bridge bulkhead	

	(rpm)	(knots)
DEAD SLOW	<u>30/40</u>	<u>4.3/5.8</u>
SLOW	<u>50/60</u>	<u>7.2/8.7</u>
HALF	<u>70/80/90</u>	<u>10.1/11.8/12.0</u>
FULL MANEUVERING	—	—
FULL NAVIGATION	—	—

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

910 ADVANCE, 1000 TRANSFER (units) nm, 3 minutes seconds

Crash stop to dead in water, DISTANCE (units) , minutes seconds

TRANSIT EVENTS
(local time)

IF INBOUND



at Bay Bridge mark
 Ship centerline 0 feet EAST WEST (circle one) of mark
 17:0441 on green range
 17:0650 on red range
 17:1810 abeam Baltimore Light
 17:4255 abeam 7 Foot Knoll
 abeam "4B"

IF OUTBOUND



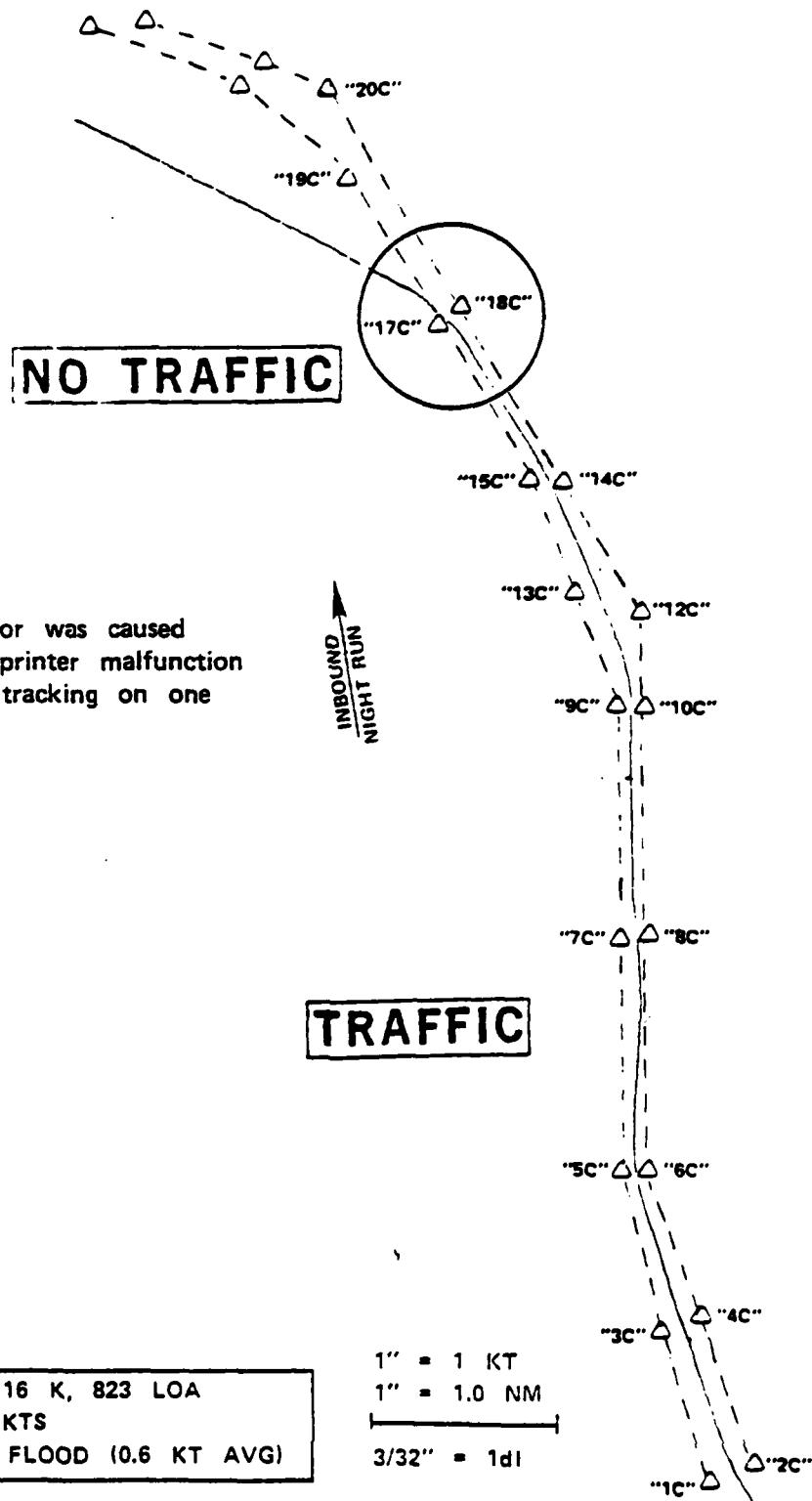
Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>342</u>	17:2400	Stbd 10
	RPM at start <u>95</u>	2430	MS
<u>17:1300</u>	abeam "1C"	2440	Stbd 10
17:1643	Stdy 343	2500	Passing traffic ship
1813	Stbd 10	2505	Stbd 05
1910	MS	2525	MS
2050	Port 15	2550	Stbd 10
2105	MS	2700	MS
2112	Stdy 004	2720	Stbd 10
2150	Stdy 005	2735	MS
2230	Port 15	2740	Port 15
2248	MS	2758	MS
2256	Stbd 10	2835	Stdy 001
2305	MS	3200	Port 10
2335	Stbd 10 - 1 Whistle	3245	MS
2350	MS	3253	Stbd 15

Local Time	Event	Local Time	Event
17:3320	MS		
3345	Stbd 10		
3355	Stbd 20		
3400	MS		
3410	Stdy 338		
3750	Port 10		
3810	MS		
3825	Stdy 329		
4100	Stdy 351		
4750	Port 15		
4815	MS		
4830	Stbd 15		
4903	MS		
4935	Stbd 10		
5000	MS		
5110	Stbd 10		
5150	Stbd 05		
5200	MS		
5220	Stbd 10		
5225	Stbd 20		
5245	Stbd 10		
5250	MS		
5320	Stdy 292		
5415	Stdy 291		
5535	Stdy 292		

TAPE IN ENVELOPE?

* USCG initial _____



SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm ≥ 5 nmSun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT STARBOARDAir temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE2 hours 54 minutes since slack FLOOD EBB (circle one) from tables0 hours 33 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulker</u>	
Propulsion	<u>Diesel</u>	
Shaft horsepower	<u>12000</u>	at <u>105</u> RPM
Length overall	<u>718</u>	(units) <u>ft</u>
Length between perpendiculars	<u>680</u>	(units) <u>ft</u>
Beam	<u>90</u>	(units) <u>ft</u>
Depth	<u>52</u>	(units) <u>ft</u>
Dead weight tonnage	<u>44,000</u>	
Gross tonnage	<u>27,000</u>	
Net tonnage	<u>18,800</u>	
Design draft	<u>39</u>	(units) <u>ft</u>
Actual draft	<u>16"</u>	FORWARD, <u>20'6"</u> AFT (units) <u> </u>
Height of eye	<u>72</u>	(units) <u>ft</u>
Bridge to bow	<u>588</u>	(units) <u>ft</u>
Bridge to stern	<u>120</u>	(units) <u>ft</u>
Antenna to ship centerline	<u>5</u>	feet <u>PORT</u> STARBOARD (circle one)
	<u>0</u>	feet AFT of bridge bulkhead

	(rpm)	(knots)
DEAD SLOW	<u>32</u>	<u>4.2</u>
SLOW	<u>55</u>	<u>7.7</u>
HALF	<u>75</u>	<u>12.5</u>
FULL MANEUVERING	<u>85</u>	<u>13.3</u>
FULL NAVIGATION	<u>112</u>	<u>14.6</u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

.46 ADVANCE, .35 TRANSFER (units) nm, 4 minutes 8 seconds

Crash stop to dead in water, .708 DISTANCE (units) nm, 5 minutes 22 seconds

TRANSIT EVENTS
(local time)

IF INBOUND



07:5700 at Bay Bridge mark
 Ship centerline 10 feet EAST WEST (circle one) of mar
08:0332 on green range
08:0548 on red range
08:2126 abeam Baltimore Light
08:5458 abeam 7 Foot Knoll
-- abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

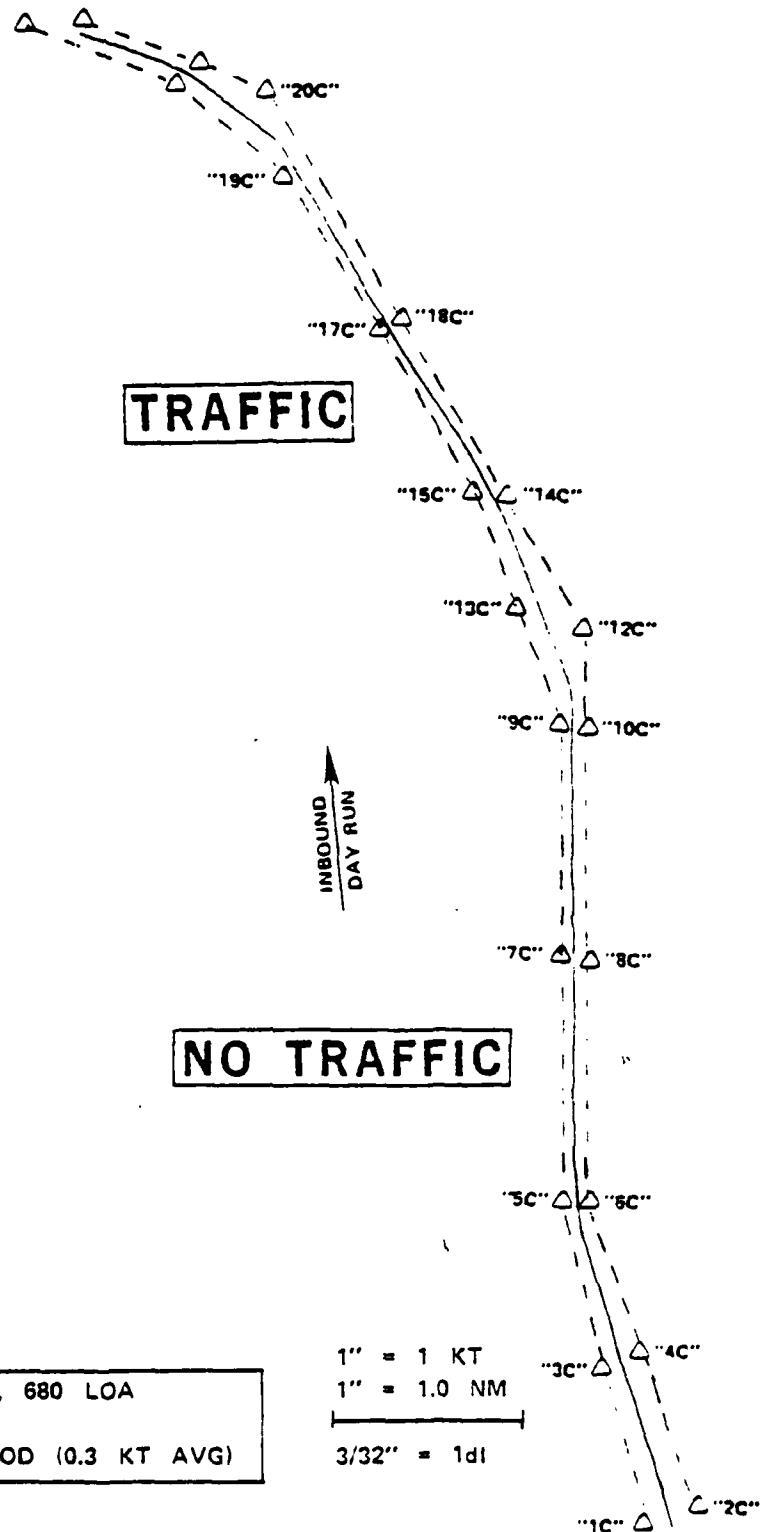
Local Time	Event	Local Time	Event
	Course at start <u>348</u>	08:2700	CC002
	RPM at start <u>95</u>	3035	CC001
<u>08:1324</u>	abeam "1C"	3559	CC002
1400	CC346	3600	"Helmsman, steer on leading light"
2250	RR15	4050	RL10
2310	RR10	4143	RL05
2320	RR05	4159	MS
2340	MS	4216	RR10
2405	RL10	4228	RR15
2415	MS	4240	MS
2440	RL05	4249	CC340
2455	RL05	4717	RL10
2500	MS	4740	RL05
2530	CC001	4743	MS
2536	CC002		
2624	CC001		

Local Time	Event
08:4810	RR05
4834	MS
4915	RR10
4929	MS
5110	RR10
5120	MS
5200	CC327
5348	RR05
5406	MS
5415	RL05
5428	RL10
5438	CC329
09:0229	RL15
0308	RL10
0314	RL05
0325	MS
0346	RR15
0416	MS
0623	RL10
0653	RL05
0733	MS
0745	RR15
0751	RR20
0801	RR05
09:0807	MS
0912	CC289
0927	CC288
1109	CC290

Local Time	Event

TAPE IN ENVELOPE?

* USCG initial _____



RUN 15

BULKER: 44 K, 680 LOA
WIND: 15 KTS
CURRENT: FLOOD (0.3 KT AVG)

1" = 1 KT
1" = 1.0 NM
3/32" = 1dI

SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm (≥ 5 nm)Sun-moon brilliance: BRIGHT-FULL HAZY QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT /STARBOARDAir temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE

0 hours 18 minutes since slack FLOOD EBB (circle one) from tables8 hours 11 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulker</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>8000</u>	at	<u>150</u> RPM
Length overall	<u>506'10"</u>	(units)	<u> </u>
Length between perpendiculars	<u>481'</u>	(units)	<u> </u>
Beam	<u>67'8"</u>	(units)	<u> </u>
Depth	<u>38'7"</u>	(units)	<u> </u>
Dead weight tonnage	<u>18,526</u>		
Gross tonnage	<u>10,209</u>		
Net tonnage	<u>6,340</u>		
Design draft	<u>30'8"</u>	(units)	<u> </u>
Actual draft	<u>24</u>	FORWARD, <u>21</u>	AFT (units) <u>ft</u>
Height of eye	<u>70</u>	(units)	<u>ft</u>
Bridge to bow	<u>380'7"</u>	(units)	<u> </u>
Bridge to stern	<u>126'3"</u>	(units)	<u> </u>
Antenna to ship centerline	<u>2</u>	feet <u>P</u> ORT STARBOARD (circle one)	<u> </u>
	<u>0</u>	feet AFT of bridge bulkhead	<u> </u>



	(rpm)	(knots)
DEAD SLOW	<u>55</u>	<u>6.0</u>
SLOW	<u>60</u>	<u>6.5</u>
HALF	<u>70</u>	<u>8.0</u>
FULL MANEUVERING	<u>100</u>	<u>11.0</u>
FULL NAVIGATION	<u>128</u>	<u>13.8</u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

.27 ADVANCE, .23 TRANSFER (units) nm, minutes seconds

Crash stop to dead in water, DISTANCE (units) , minutes seconds

TRANSIT EVENTS
(local time)

IF INBOUND



— at Bay Bridge mark
 Ship centerline ____ feet EAST WEST (circle one) of mark
 — on green range
 — on red range
16:1915 abeam Baltimore Light
15:5006 abeam 7 Foot Knoll
15:3528 abeam "4B"

IF OUTBOUND



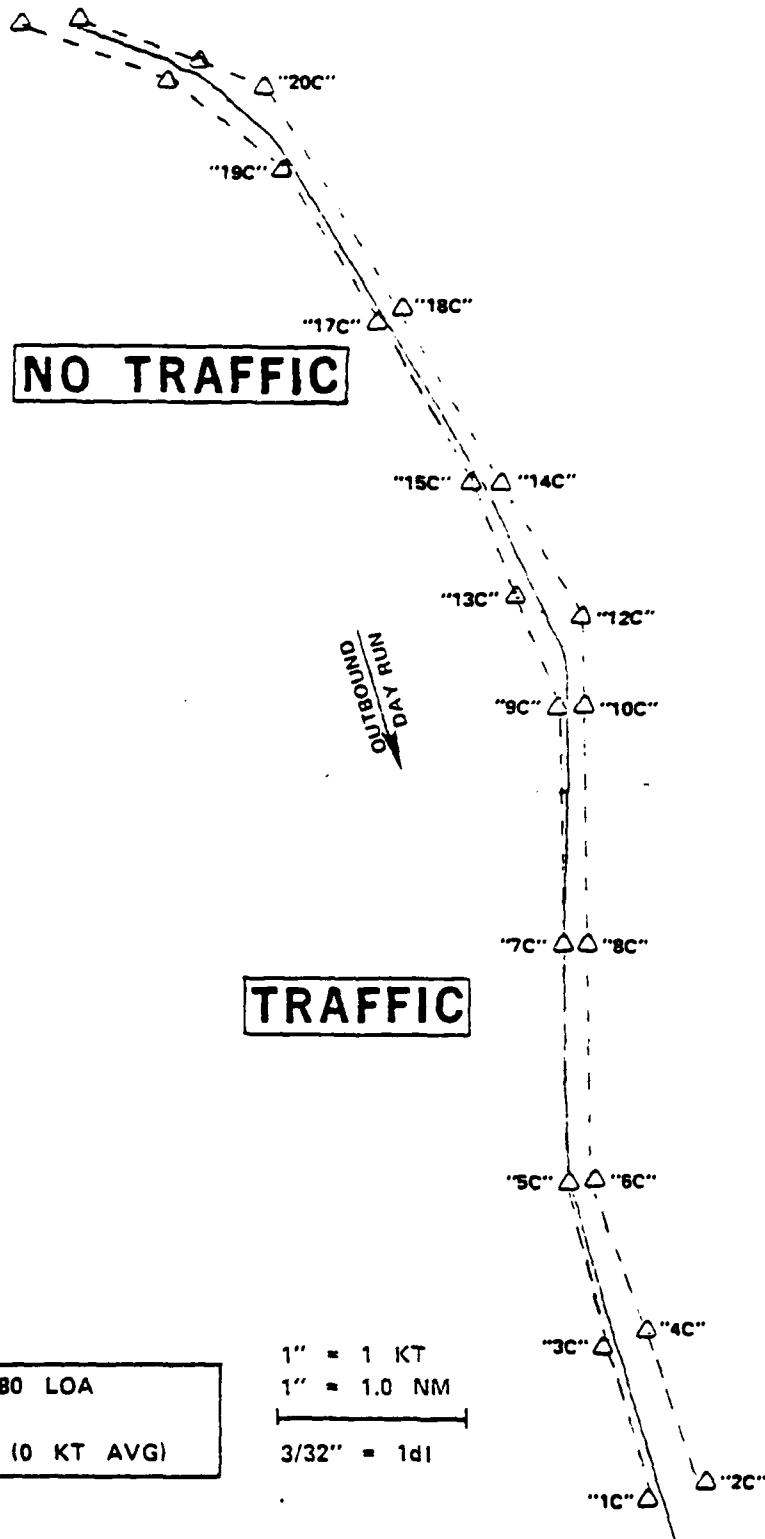
Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>112</u>	15:4735	CC151
	RPM at start <u>95</u>	5020	CC150
<u>15:35+</u>	abeam "4B"	5145	CC151
15:3616	CC111	5419	Stbd 15
3830	Stbd 15	5435	MS
3915	MS	5446	CC156
3932	Port 10	5929	Stbd 15
3954	MS	5935	Stbd 20
4000	CC133	16:0013	MS
4137	Stbd 15	0021	Port 15
4155	Stbd 10	0038	MS
4218	MS	0050	CC180
4255	Port 10	0202	Radioed to traffic Altered course to Stbd
4309	MS	0405	CC181
4315	CC150	0806	CC180
4422	CC149	0903	CC179
4512	CC150		

Local Time	Event	Local Time	Event
16:1231	RLOS	16:3910	CC195
1238	Traffic abeam		Under bridge
1245	MS	4014	Stbd 10
1252	RR10	4028	Stbd 05
1303	MS		
1310	CC176		
1426	Radioed to traffic		
1518	Port 10		
1553	MS		
1619	Stbd 10		
1646	MS		
1810	CC162		
2108	CC161		
2858	Traffic ship seen on radar beyond bridge		
3224	Stbd 15		
3246	Radioed traffic ship beyond bridge		
3332	MS		
3408	Port 15		
3412	MS		
3420	CC194		
3506	CC193		
3706	CC194		

TAPE IN ENVELOPE?

* USCG initial _____



SHIP TRACKING REPORT

RUN CONDITION
(circle one)

Direction: INBOUND OUTBOUND

Time: DAY NIGHT

Method: VISUAL RADAR PATH RACON

INITIAL ENVIRONMENT
(circle one)

Weather: STABLE IMPROVING DETERIORATING

Sky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCAST

Precipitation: NONE DRIZZLE RAIN SNOW FOG

Visibility: 1/2 nm 1 nm 3 nm ≥ 5 nm

Sun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE NEW

Sun-moon direction: FORWARD AFT PORT /STARBOARD

Air temperature (F): 30 30-50 51-70 70

Sea temperature (F): 30 30-50 51-70 70

True wind direction: N NE E SE S SW W NW

True wind speed: 3-10 11-20 21-30 30

Sea state: CALM SLIGHT SMALL MEDIUM LARGE

4 hours 15 minutes since slack FLOOD EBB (circle one) from tables

7 hours 41 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Tanker</u>	
Propulsion	<u>Diesel</u>	
Shaft horsepower	<u>12,000</u>	at <u>122</u> RPM
Length overall	<u>170.624</u>	(units) <u>meters</u>
Length between perpendiculars	<u>161.936</u>	(units) <u>meters</u>
Beam	<u>26.024</u>	(units) <u>meters</u>
Depth	<u>14.445</u>	(units) <u>meters</u>
Dead weight tonnage	<u>31,944</u>	
Gross tonnage	<u>18,203</u>	
Net tonnage	<u>12,332</u>	
Design draft	<u>36'11"</u>	(units)
Actual draft	<u>33</u>	FORWARD, <u>33</u> AFT (units) <u>ft</u>
Height of eye	<u>100</u>	(units) <u>ft</u>
Bridge to bow	<u>420</u>	(units) <u>ft</u>
Bridge to stern	<u>136</u>	(units) <u>ft</u>
Antenna to ship centerline	<u>15</u>	feet <u>P</u> ORT STARBOARD (circle one)
	<u>0</u>	feet AFT of bridge bulkhead

	(rpm)	(knots)
DEAD SLOW	<u>35</u>	<u>4.81</u>
SLOW	<u>45</u>	<u>6.18</u>
HALF	<u>60</u>	<u>8.24</u>
FULL MANEUVERING	<u>90</u>	<u>12.37</u>
FULL NAVIGATION	<u>125</u>	<u>16.76</u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data 8.3 MEAN DRAFT (units) meters 106 RPM

394 ADVANCE, 258 TRANSFER (units) meters 1 minutes 23 seconds

Crash stop to dead in water, .45 DISTANCE (units) nm, 3 minutes 35 seconds

TRANSIT EVENTS
(local time)

IF INBOUND



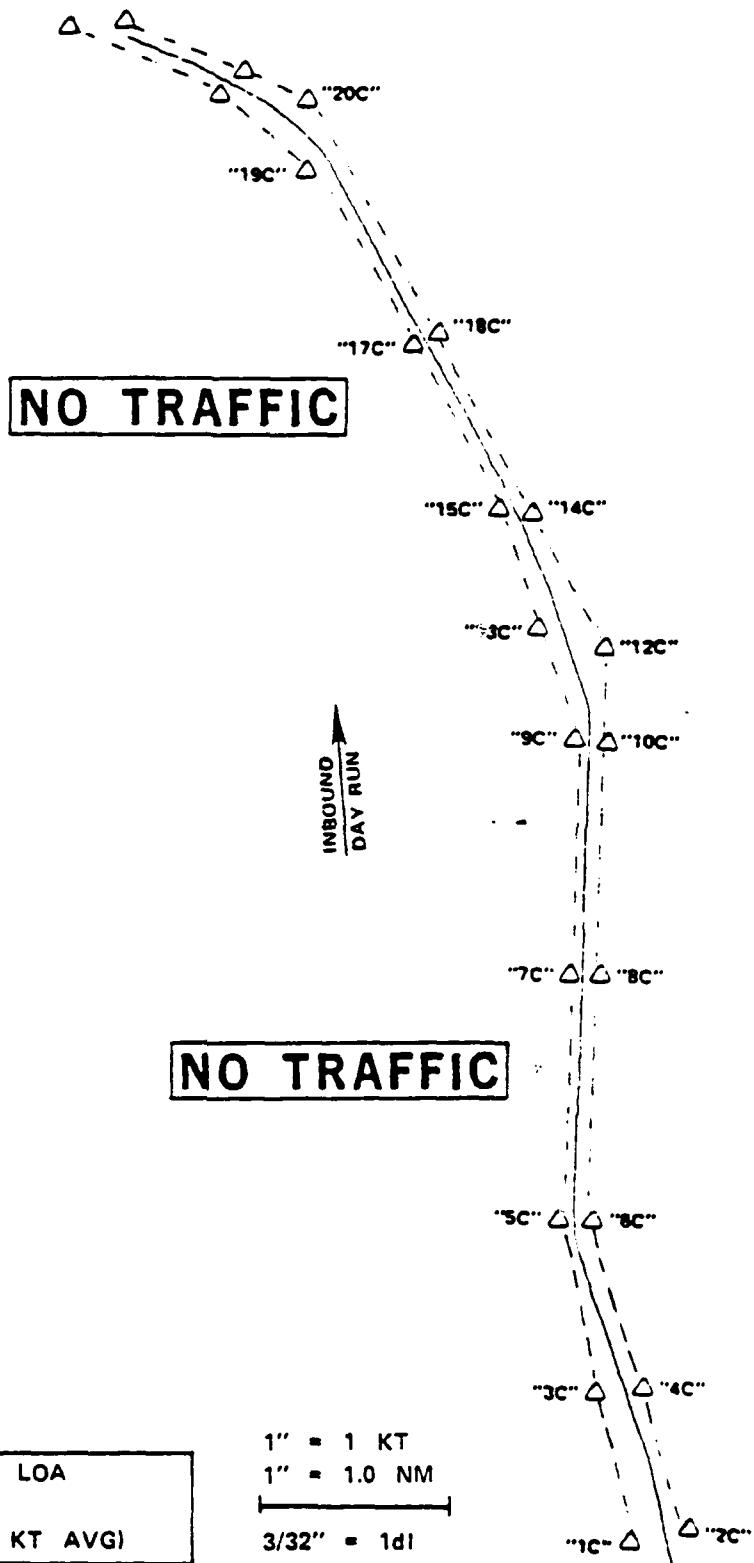
15:0115 at Bay Bridge mark
 Ship centerline _____ feet EAST WEST (circle one) of mark
15:0732 on green range
15:0950 on red range
15:2330 abeam Baltimore Light
15:5408 abeam 7 Foot Knoll
16:0850 abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>345</u>	15:4612	CC335
	RPM at start <u>90</u>	4942	Port 10
<u>15:1600</u>	abeam "1C"	4945	CC330
<u>16:0003</u>	CC340	16:0105	Port 10
	Stbd 10 pilot is Greek hard to understand	0108	MS
2523	MS	0141	Stbd 10
2614	CC000	0215	MS
2641	Steady 000	0609	CC292
2731	CC001 1/2 degree gyro error		
3703	CC000 - Overtaking tug/barge		
3929	Half ahead passing tug/barge		
4111	Port 10		
4116	MS		
4218	Stbd 20		
4329	CC340		
4343	Full ahead		



SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm ≥ 5 nmSun-moon brilliance: BRIGHT FULL HAZY-QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT STARBOARDAir temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE0 hours 32 minutes since slack FLOOD EBB (circle one) from tables5 hours 03 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Coal-Bulker</u>		
Propulsion	<u>Turbine</u>		
Shaft horsepower	<u>17,500</u>	at <u>110</u>	RPM
Length overall	<u>789.6</u>	(units)	<u>ft</u>
Length between perpendiculars	<u>844.1</u>	(units)	<u>ft</u>
Beam	<u>104</u>	(units)	<u>ft</u>
Depth	<u>57</u>	(units)	<u>ft</u>
Dead weight tonnage	<u>59,780</u>		
Gross tonnage	<u>33,290</u>		
Net tonnage	<u>21,914</u>		
Design draft	<u>42</u>	(units)	<u>ft</u>
Actual draft	<u>12.6</u>	FORWARD, <u>23.6</u>	AFT (units) <u>ft</u>
Height of eye	<u>75</u>	(units)	<u>ft</u>
Bridge to bow	<u>200</u>	(units)	<u>ft</u>
Bridge to stern	<u>48</u>	(units)	<u>ft</u>
Antenna to ship centerline	<u>0</u>	feet PORT STARBOARD	(circle one)
	<u>3</u>	feet AFT of bridge bulkhead	

	(rpm)	(knots)
DEAD SLOW	<u>20</u>	<u>3.3</u>
SLOW	<u>35</u>	<u>5.8</u>
HALF	<u>50</u>	<u>8.3</u>
FULL MANEUVERING	<u>70</u>	<u>11.6</u>
FULL NAVIGATION	—	—

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units), RPM

ADVANCE, TRANSFER (units), minutes seconds

Crash stop to dead in water, 1.207 DISTANCE (units) meters, 8 minutes 26 seconds

TRANSIT EVENTS
(local time)

IF INBOUND



12:5820 at Bay Bridge mark
 Ship centerline 0 feet EAST WEST (circle one) of mark
13:0357 on green range
13:0548 on red range
— abeam Baltimore Light
13:4614 abeam 7 Foot Knoll
— abeam "4B"

IF OUTBOUND



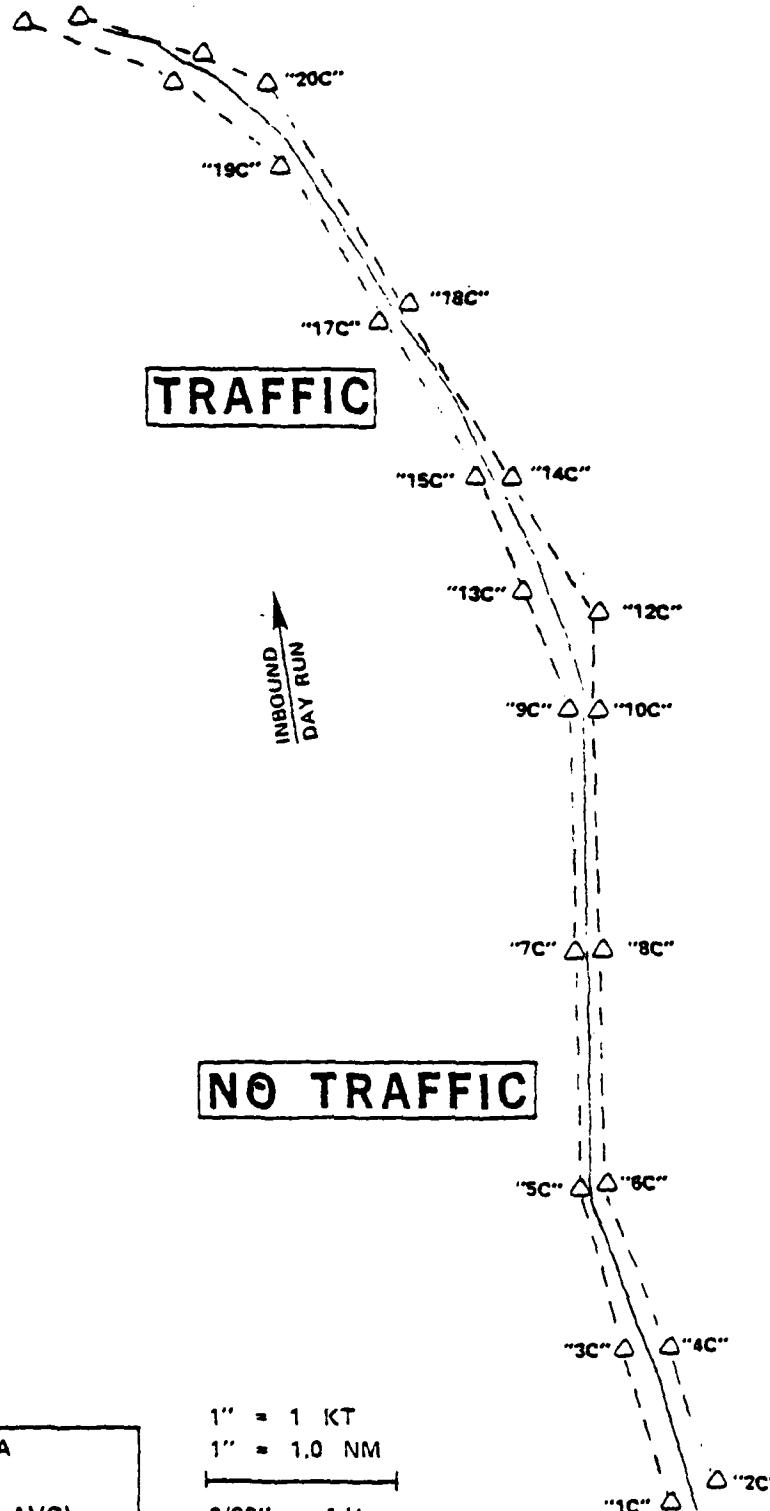
Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>346</u>	13:3515	Port 15
	RPM at start <u>70</u>	3552	Ease to Port 10
<u>13:1222</u>	abeam "1C"	3608	MS
	Moving to right on visual will move to left before turn No traffic	3615	Stbd 10
		3635	MS
13:1448	CC342	3643	CC342
1600	Pilot using radar	3759	CC340
2005	Stbd 10	4005	CC338
2051	MS	4010	CC337
2111	Port 15	4058	CC335
2130	MS	4152	CC333
2140	Port 10	4226	Changed to 1½ mile scale on radar to match traffic
2155	CC003	4242	CC335
2319	CC002	4323	CC336
2645	CC001	4459	½ mile scale on radar
2940	CC002		

Local Time	Event	Local Time	Event
13:4515	CC333		
4539	Traffic ship abeam		
4616	CC330		
4705	Stbd 15		
4727	MS		
4753	CC229		
4828	Port 15		
4838	MS		
4847	CC330 - visual ship swinging pilot gave correction		
5315	Pilot not trying to stay in center		
5416	Port 10		
5450	CC313		
5645	Port 10		
5659	Port 15		
5734	CC293		
5738	CC292		
5800	CC291		
5942	CC288		
14:0122	CC292		

TAPE IN ENVELOPE?

* USCG initial _____



RUN 18

BULKER: 60 K, 744 LOA

WIND: 15 KTS

CURRENT: EBB (0.2 KT AVG)

1" = 1 KT

1" = 1.0 NM

— 3/32" = 1d1

SHIP TRACKING REPORT

RUN CONDITION
(circle one)

Direction: INBOUND OUTBOUND

Time: DAY NIGHT

Method: VISUAL RADAR PATH RACON

INITIAL ENVIRONMENT
(circle one)

Weather: STABLE IMPROVING DETERIORATING

Sky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCAST

Precipitation: NONE DRIZZLE RAIN SNOW FOG

Visibility: 1/2 nm 1 nm 3 nm 5 nm

Sun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE NEW

Sun-moon direction: FORWARD AFT PORT /STARBOARD

Air temperature (F): 30 30-50 51-70 70

Sea temperature (F): 30 30-50 51-70 70

True wind direction: N NE E SE S SW W NW

True wind speed: 3 3-10 11-20 21-30 30

Sea state: CALM SLIGHT SMALL MEDIUM LARGE

5 hours 05 minutes since slack FLOOD EBB (circle one) from tables

6 hours 28 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>Bulk-Coal</u>			
Propulsion	<u>Diesel</u>			
Shaft horsepower	_____ at _____ RPM			
Length overall	737	(units)	ft	
Length between perpendiculars	705	(units)	ft	
Beam	106	(units)	ft	
Depth	58	(units)	ft	
Dead weight tonnage	61,745			
Gross tonnage	35,800			
Net tonnage	31,270			
Design draft	41	(units)	ft	
Actual draft	19	FORWARD,	24	AFT (units) ft
Height of eye	90	(units)	ft	
Bridge to bow	611	(units)	ft	
Bridge to stern	125	(units)	ft	
Antenna to ship centerline	0	feet PORT	STARBOARD	(circle one)
	0	feet AFT of bridge bulkhead		

	(rpm)	(knots)
DEAD SLOW	_____	_____
SLOW	_____	_____
HALF	_____	_____
FULL MANEUVERING	_____	_____
FULL NAVIGATION	_____	_____

NOT NOTED

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data _____ MEAN DRAFT (units) _____, _____ RPM

NOT NOTED _____ ADVANCE, _____ TRANSFER (units) _____, _____ minutes _____ seconds

Crash stop to dead in water, _____ DISTANCE (units) _____, _____ minutes _____ seconds

TRANSIT EVENTS
(local time)

IF INBOUND



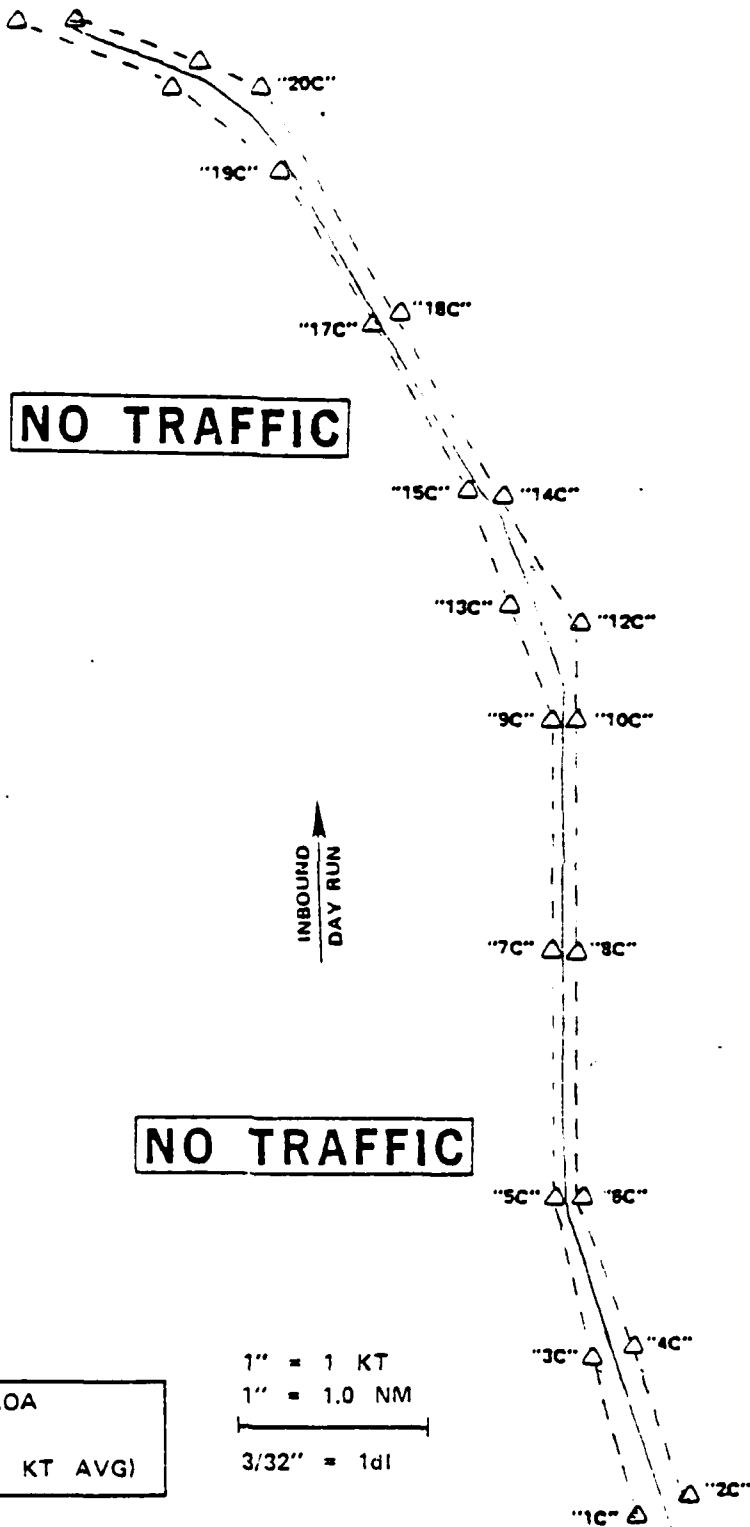
13:4300 at Bay Bridge mark
 Ship centerline 0 feet EAST WEST (circle one) of mark
 _____ on green range
 _____ on red range
 _____ abeam Baltimore Light
 _____ abeam 7 Foot Knoll
 _____ abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>342</u>	14:2800	Stdy 243
<u>13:5610</u>	RPM at start <u>89</u>	3255	Stdy 243
	abeam "1C"	3940	Port 20
14:0000	Stdy 342	3950	Passing tug/barge port side
0430	Stbd 15	4000	MS
0508	MS	4135	Stbd 10
0525	Port 10	4240	Port 20
0545	Stdy 000	4307	MS
0740	Stdy 000	4325	Stbd 15
1720	Stdy 001	4335	Stdy 239
2015	Port 20		
2100	MS		
2105	Stdy 339		
2600	Stbd 20		
2750	MS		



RUN 19

BULKER: 62 K, 705 LOA
WIND: 5 KTS
CURRENT: FLOOD (0.4 KT AVG)

1'' = 1 KT
1'' = 1.0 NM
3/32'' = 1 dl

SHIP DESCRIPTION

Type	<u>Bulker</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>8000</u>	at	<u>150</u> RPM
Length overall	<u>506'10"</u>	(units)	<u>ft</u>
Length between perpendiculars	<u>481'</u>	(units)	<u>ft</u>
Beam	<u>67'8"</u>	(units)	<u>ft</u>
Depth	<u>38'7"</u>	(units)	<u>ft</u>
Dead weight tonnage	<u>18,526</u>		
Gross tonnage	<u>10,209</u>		
Net tonnage	<u>6,340</u>		
Design draft	<u>30'8"</u>	(units)	<u>ft</u>
Actual draft	<u>24</u>	FORWARD,	<u>21</u> AFT (units) <u>ft</u>
Height of eye	<u>70</u>	(units)	<u>ft</u>
Bridge to bow	<u>380'7"</u>	(units)	<u>ft</u>
Bridge to stern	<u>126'3"</u>	(units)	<u>ft</u>
Antenna to ship centerline	<u>2</u>	feet <u>PORT</u> STARBOARD (circle one)	<u>ft</u>
	<u>0</u>	feet AFT of bridge bulkhead	

	(rpm)	(knots)
DEAD SLOW	<u>55</u>	<u>6.0</u>
SLOW	<u>60</u>	<u>6.5</u>
HALF	<u>70</u>	<u>8.0</u>
FULL MANEUVERING	<u>100</u>	<u>11.0</u>
FULL NAVIGATION	<u>128</u>	<u>13.8</u>

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

 .27 ADVANCE, .23 TRANSFER (units) , minutes seconds

Crash stop to dead in water, DISTANCE (units) , minutes seconds

SHIP TRACKING REPORT

RUN CONDITION
(circle one)

Direction: INBOUND OUTBOUND

Time: DAY NIGHT

Method: VISUAL RADAR PATH RACON

INITIAL ENVIRONMENT
(circle one)

Weather: STABLE IMPROVING DETERIORATING

Sky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCAST

Precipitation: NONE DRIZZLE RAIN SNOW FOG

Visibility: 1/2 nm 1 nm 3 nm ≥ 5 nm

Sun-moon brilliance: BRIGHT FULL HAZY-QUARTER OBSCURE-NEW

Sun-moon direction: FORWARD AFT PORT STARBOARD

Air temperature (F): <30 30-50 51-70 70

Sea temperature (F): 30 30-50 51-70 70

True wind direction: N NE E SE S SW W NW

True wind speed: 3 3-10 11-20 21-30 30

Sea state: CALM SLIGHT SMALL MEDIUM LARGE

5 hours 28 minutes since slack FLOOD EBB (circle one) from tables

1 hours 14 minutes since sun RISE SET (circle one) from tables

TRANSIT EVENTS
(local time)

IF INBOUND



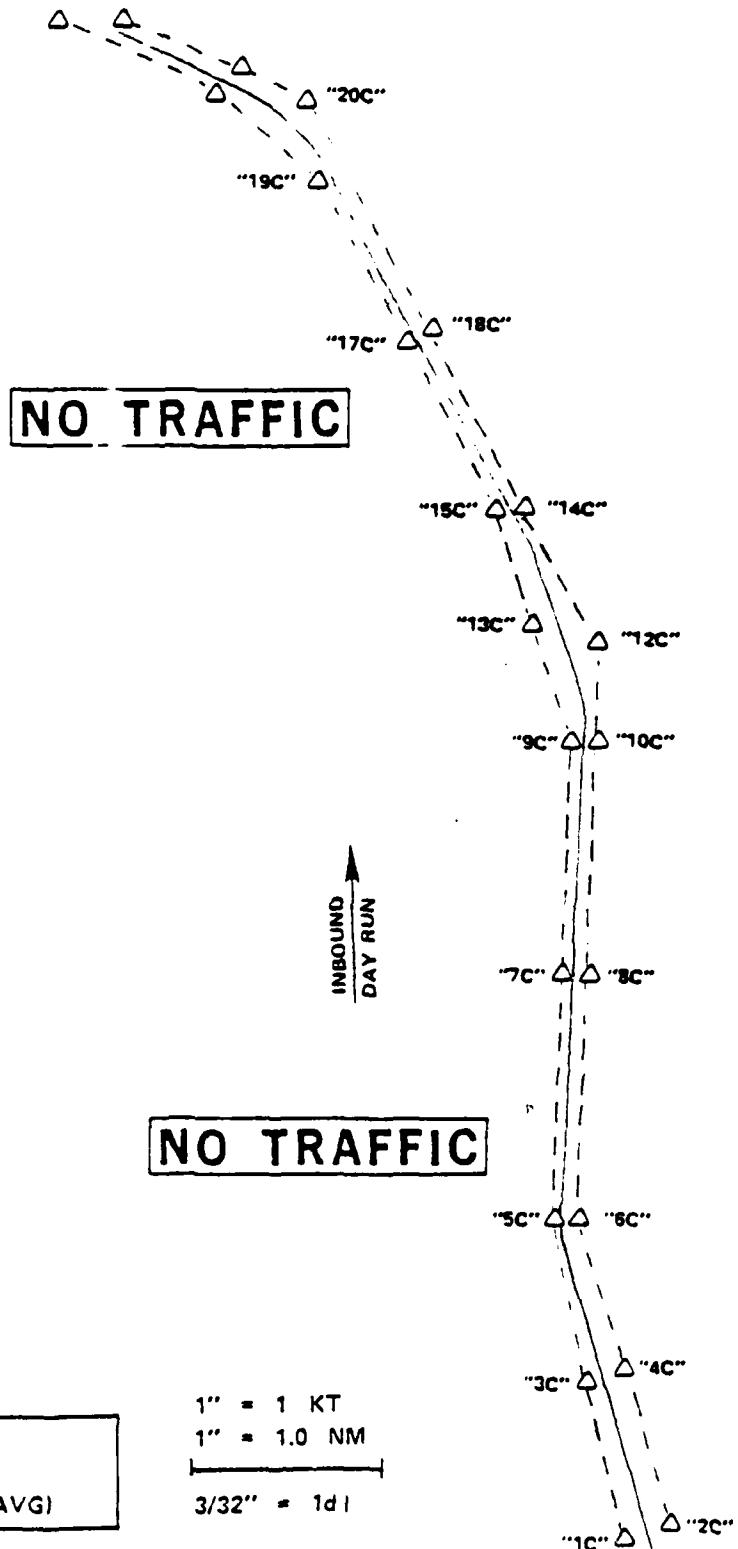
08:4202 at Bay Bridge mark
 Ship centerline 10 feet EAST WEST (circle one) of mark
08:5023 on green range
08:5343 on red range
09:1117 abeam Baltimore Light
09:4658 abeam 7 Foot Knoll
— abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>345</u>	09:5346	RL10
	RPM at start <u>100</u>	5505	MS
<u>09:0218</u>	abeam "1C"	5548	RL10
09:1314	RR10	5602	RL05
1355	MS	5708	MS
1448	CC002	5737	CC295
3222	RL10	10:0228	Finex
3230	Half ahead - Slowing for CG buoy tender towing buoy		
3328	MS		
3357	Slow ahead		
3634	Full ahead		
3955	RL10		
4015	MS		
4115	CC331 - Gyro error to 329		
4639	CC331		
4943	CC332		



RUN 20

BULKER: 18 K, 481 LOA

WIND: 15 KTS

CURRENT: EBB (0.2 KT AVG)

SHIP TRACKING REPORT

RUN CONDITION
(circle one)Direction: INBOUND OUTBOUNDTime: DAY NIGHTMethod: VISUAL RADAR PATH RACONINITIAL ENVIRONMENT
(circle one)Weather: STABLE IMPROVING DETERIORATINGSky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCASTPrecipitation: NONE DRIZZLE RAIN SNOW FOGVisibility: 1/2 nm 1 nm 3 nm ≥ 5 nmSun-moon brilliance: BRIGHT-FULL HAZY QUARTER OBSCURE-NEWSun-moon direction: FORWARD AFT PORT /STARBOARDAir temperature (F): 30 30-50 51-70 70Sea temperature (F): 30 30-50 51-70 70True wind direction: N NE E SE S SW W NWTrue wind speed: 3 3-10 11-20 21-30 30Sea state: CALM SLIGHT SMALL MEDIUM LARGE4 hours 47 minutes since slack FLOOD EBB (circle one) from tables7 hours 33 minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Type	<u>USCG Buoy Tender</u>		
Propulsion	<u>Diesel</u>		
Shaft horsepower	<u>2900 hp</u>	at	<u>RPM</u>
Length overall	<u>157</u>	(units)	<u>ft</u>
Length between perpendiculars	<u>_____</u>	(units)	<u>_____</u>
Beam	<u>31</u>	(units)	<u>ft</u>
Depth	<u>_____</u>	(units)	<u>_____</u>
Dead weight tonnage	<u>525</u>		
Gross tonnage	<u>_____</u>		
Net tonnage	<u>_____</u>		
Design draft	<u>_____</u>	(units)	<u>_____</u>
Actual draft	<u>6'7"</u>	FORWARD,	<u>_____</u> AFT (units) <u>_____</u>
Height of eye	<u>_____</u>	(units)	<u>_____</u>
Bridge to bow	<u>_____</u>	(units)	<u>_____</u>
Bridge to stern	<u>_____</u>	(units)	<u>_____</u>
Antenna to ship centerline	<u>_____</u>	feet	PORT STARBOARD (circle one)
	<u>_____</u>	feet	AFT of bridge bulkhead

	(rpm)	(knots)
DEAD SLOW	—	—
SLOW	—	—
HALF	—	—
FULL MANEUVERING	—	—
FULL NAVIGATION	—	—

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data MEAN DRAFT (units) , RPM

ADVANCE, TRANSFER (units), minutes seconds

TRANSIT EVENTS
(local time)

IF INBOUND



15:0746 at Bay Bridge mark
 Ship centerline 20 feet EAST WEST (circle one) of mark
15:1410 on green range
15:1638 on red range
— abeam Baltimore Light
— abeam 7 Foot Knoll
— abeam "4B"

IF OUTBOUND



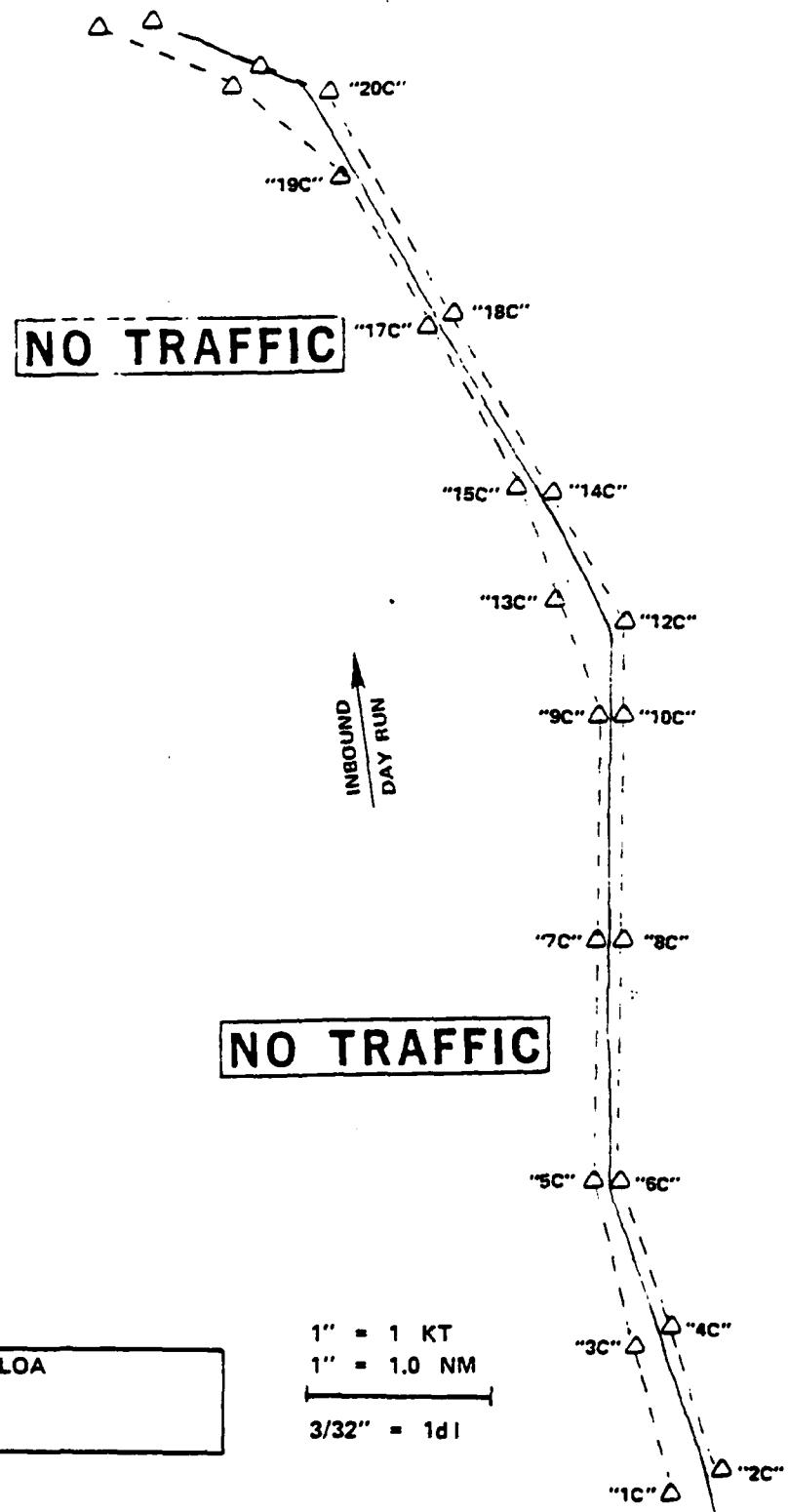
Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start <u>—</u>	15:4400	CC355 Noted crab angle of 3-4 deg
	RPM at start <u>10Kts</u>	4600	CC356
	abeam	4700	CC358
15:34	Abeam 6C CC359	4900	CC357
3510	CC357 Radioed traffic ship	5000	CC356
3630	CC355	5310	RL10
3900	RL10	5320	RL05
3910	MS - RR05	5325	MS
3920	RR10	5330	RR05
3930	MS	5340	RR10
3940	RR05	5343	MS
3945	MS	5350	CC332
4000	CC358	5400	CC330
4100	CC357	5430	CC329
4300	CC356	5600	CC328

Local Time	Event	Local Time	Event
15:5700	CC327		
5800	CC326		
5900	CC324		
16:0000	Estimated wind speed 30-35Knots NW		
0100	CC325		
0300	CC326		
0400	15ft West of C _L		
0500	CC327		
0800	On C _L		
1300	End Range Run		
1410	RL10		
1430	RL05		
1445	MS		
1455	RR05		
	MS		
16:1500	CC291		

TAPE IN ENVELOPE?

* USCG initial _____



RUN 21

USCG: .5 K, 157 LOA
WIND: 15 KTS
CURRENT:

1" = 1 KT
1" = 1.0 NM
3/32" = 1d1

(THIS PAGE INTENTIONALLY LEFT BLANK)

Appendix B
OBSERVER'S DATA COLLECTION BOOKLET

This appendix is a copy of the Data Collection Booklet which was carried aboard each ship for the purpose of recording relevant ship design data, environmental conditions, and transit events. The booklet also contains information necessary to conduct the experiment such as RAYDIST operating instructions and logistics information.

RUN NUMBER _____

SHIP TRACKING REPORT

Date _____

(circle one)

Pilot's name _____

Tracking crew _____

EA USCG

EA USCG

EA USCG

RUN CONDITION
(circle one)

Direction: INBOUND OUTBOUND

Time: DAY NIGHT

Method: VISUAL RADAR ONLY WITHOUT RANGES

INITIAL ENVIRONMENT
(circle one)

Weather: STABLE IMPROVING DETERIORATING

Sky: CLEAR PARTLY CLOUDY PARTLY CLEAR OVERCAST

Precipitation: NONE DRIZZLE RAIN SNOW FOG

Visibility: $\leq 1/2$ nm 1 nm 3 nm ≥ 5 nm

Sun-moon brilliance: BRIGHT-FULL HAZY-QUARTER OBSCURE-NEW

Sun-moon direction: FORWARD AFT PORT STARBOARD

Air temperature (F): <30 30-50 51-70 >70

Sea temperature (F): <30 30-50 51-70 >70

True wind direction: N NE E SE S SW W NW

True wind speed: <3 3-10 11-20 21-30 >30

Sea state: CALM SLIGHT SMALL MEDIUM LARGE

Ice concentration: NONE OPEN WATER OPEN PACK CLOSED PACK

_____ hours _____ minutes since slack FLOOD EBB (circle one) from tables

_____ hours _____ minutes since sun RISE SET (circle one) from tables

SHIP DESCRIPTION

Vessel name _____
 Registry _____
 Official number _____
 Year built _____
 Type _____
 Propulsion _____
 Shaft horsepower _____ at _____ RPM
 Length overall _____ (units) _____
 Length between perpendiculars _____ (units) _____
 Beam _____ (units) _____
 Depth _____ (units) _____
 Dead weight tonnage _____
 Gross tonnage _____
 Net tonnage _____
 Design draft _____ (units) _____
 Actual draft  FORWARD, _____ AFT (units) _____
 Height of eye _____ (units) _____
 Bridge to bow _____ (units) _____
 Bridge to stern _____ (units) _____
 Antenna to ship centerline _____ feet PORT STARBOARD (circle one)
 _____ feet AFT of bridge bulkhead

	(rpm)	(knots)
DEAD SLOW	_____	_____
SLOW	_____	_____
HALF	_____	_____
FULL MANEUVERING	_____	_____
FULL NAVIGATION	_____	_____

Maneuvering data at full ahead, ballast condition and starboard turn

Maneuvering data _____ MEAN DRAFT (units) _____, _____ RPM

_____ ADVANCE, _____ TRANSFER (units) _____, _____ minutes _____ seconds

Crash stop to dead in water, _____ DISTANCE (units) _____, _____ minutes _____ seconds

<u>ID</u>	<u>BRIDGE EQUIPMENT</u>	<u>ONBOARD</u>	<u>MFG-MODEL</u>	<u>ERROR</u>
1	Steering stand	—	_____	
2	EOT	—	_____	
3	Gyro repeater	—	_____	(direction) _____
4	Rudder angle indicator	—	_____	
5	RPM indicator	—	_____	
6	Rate of turn indicator	—	_____	
7	Clinometer	—	_____	
8	Clock	—	_____	<u>USED BY PILOT</u>
9	Radar #1	—	_____	—
10	Radar #2	—	_____	—
11	ARPA	—	_____	—
12	Depth sounder	—	_____	
13	Wind indicator	—	_____	
14	Speed log	—	_____	
15	Bell log	—	_____	
16	Whistle control	—	_____	
17	VHF comm	—	_____	
18	Inter comm	—	_____	
19	Radio aids to nav	—	_____	
20	PILOTS PRIMARY STATION			
21	PILOTS SECONDARY STATIONS			
22	RAYDIST EQUIPMENT LOCATION			

(Sketch of bridge and location of equipment)

PHOTO LOG

Roll No.	Photo No.	Description of Photograph

TRANSIT EVENTS

(local time)

IF INBOUND



_____ at Bay Bridge mark

Ship centerline _____ feet EAST WEST (circle one) of mark

_____ on green range

_____ on red range

_____ abeam Baltimore Light

_____ abeam 7 Foot Knoll

_____ abeam "4B"

IF OUTBOUND



Aids to navigation discrepancies (use attached chart):

Local Time	Event	Local Time	Event
	Course at start _____		
	RPM at start _____		
	abeam "1C"		

Local Time	Event

Local Time	Event

TAPE IN ENVELOPE?

* USCG initial _____

BALTIMORE HARBOR APPROACH (OFF SANDY PT.), MD., 1980
 F-FLOOD, DIR. 025° TRUE E-EBB, DIR. 190° TRUE

75

NOVEMBER												DECEMBER												
DAY	SLACK			MAXIMUM			SLACK	MAXIMUM			SLACK	MAXIMUM			SLACK	MAXIMUM			SLACK	MAXIMUM				
	WATER	CURRENT	TIME	WATER	CURRENT	TIME		WATER	CURRENT	TIME		WATER	CURRENT	TIME		WATER	CURRENT	TIME		WATER	CURRENT	TIME		
	H.M.	H.M.	KNOTS		H.M.	H.M.		H.M.	H.M.	KNOTS		H.M.	H.M.	KNOTS		H.M.	H.M.	KNOTS		H.M.	H.M.	KNOTS		
1	0245	0607	0.3E	16	0229	0514	0.3E	1	0009	0.6F	16	0219	0543	0.8E					16	0219	0543	0.8E		
SA	0932	1236	0.7F	SU	0858	1201	0.7F	SA	0253	0518	0.3E	TU	0851	1220	1.0F					TU	0851	1220	1.0F	
1549	1839	0.5E		1516	1807	0.5E		0931	1251	0.9F		1551	1850	0.7E		1621	1917	0.6E		1621	1917	0.6E		
				2058				1622				2206				2224				2224				
2		0043	0.7F	17		0004	0.6F		2	0106	0.5F	17								0314	0634	0.8E		
SU	0341	0702	0.3E	M	0302	0623	0.3E	TU	0347	0706	0.3E		0314	0634	0.8E		1012	1340	0.3F		0935	1109	1.1F	
1017	1329	0.3F		0937	1252	0.3F		1012	1340	0.3F		1020	1402	1.2F		1612	1909	0.7E		1645	1931	0.8E		
1646	1942	0.7E		1612	1909	0.7E		1709	2013	0.7E		1736	2046	1.0E		2214	2328			2319				
M	0435	0751	0.3E	TU	0355	0710	0.3E		0439	0752	0.7E	TH	0411	0727	0.8E		1051	1423	1.0F		1020	1402	1.2F	
1100	1416	0.3F		1016	1340	1.0F		1753	2102	0.8E		1736	2046	1.0E		2324				2324				
1735	2033	0.7E		1704	2007	0.8E										1129	1505	1.0F		1107	1451	1.3F		
																1835	2145	0.9E		1826	2139	1.1E		
4		0234	0.6F	19		0207	0.6F		4	0026	0255	0.5F	19	0023	0243	0.5F								
TU	0525	0836	0.8E	M	0448	0800	0.8E	TH	0529	0836	0.7E		0509	0820	0.8E		1139	1502	1.1F		1107	1451	1.3F	
1139	1502	0.3F		1057	1429	1.1F		1129	1505	1.0F		1107	1451	1.3F		1820	2124	0.8E		1820	2124	0.8E		
S	0039	0323	0.5F	20	0027	0302	0.5F	S	0119	0346	0.5F	20	0120	0340	0.5F									
W	0612	0920	0.3E	TU	0541	0847	0.3E	F	0618	0919	0.5E	SA	0607	0911	0.8E		1205	1547	1.1F		1156	1540	1.3F	
1215	1540	1.0F		1139	1514	1.2F		1205	1547	1.1F		1914	2230	1.0E		1914	2228	1.2E						
1301	2208	0.3E		1842	2154	1.1E										1930	2245	1.2E		1930	2245	1.2E		
6	0130	0412	0.6F	21	0125	0357	0.6F	S	0208	0433	0.5F	21	0212	0434	0.6F									
TH	0657	0953	0.7E	F	0633	0936	0.8E	SA	0705	1000	0.5E	SU	0705	1007	0.7E		1223	1601	1.3F		1246	1629	1.3F	
1250	1613	1.0F		1223	1601	1.3F		1240	1624	1.1F		1300	2251	1.0E		1300	2251	1.0E		2001	2320	1.2E		
				1930	2251	1.2E		1933	2309	1.0E						2309				2309				
7	0219	0455	0.6F	22	0220	0449	0.6F	7	0255	0518	0.5F	22	0300	0526	0.6F									
F	0739	1037	0.7E	SU	0725	1025	0.3E	SU	0750	1041	0.6E	M	0802	1058	0.7E		1323	1655	1.4F		1337	1721	1.3F	
1323	1655	1.0F		1308	1648	1.4F		1316	1732	1.1F		2047	2332	1.0E		2018	2332	1.0E		2047	2332	1.0E		
8	0035	0537	0.6F	23	0312	0540	0.5F	8	0339	0601	0.5F	23	0346	0616	0.6F									
SA	0821	1114	0.8E	SU	0818	1114	0.8E	M	0835	1123	0.5E	TU	0900	1151	0.7E		1356	1731	1.1F		1429	1806	1.2F	
1356	1731	1.1F		1356	1731	1.3F		1353	1741	1.1F		2132				2104				2132				
SU	0013	1.0E		24	0023	1.2E		9	0032	1.1E		24	0430	0707	0.7F									
3352	0622	0.5F	M	0402	0632	0.6F	TU	0422	0645	0.5F		0430	0707	0.7F		0903	1154	1.3F		0958	1245	0.7E		
1429	1808	1.0F		0913	1204	0.7E		0921	1204	0.5E		0958	1245	0.7E		1445	1826	1.3F		1523	1857	1.1F		
				1445	1826	1.3F		1433	1823	1.1F		1523	1857	1.1F		2152				2152				
10		0056	1.0E	25	0112	1.2E		10	0115	1.0E		25	0139	1.1E										
M	0438	0704	0.5F	TU	0452	0726	0.7F		0503	0727	0.5F	TH	0514	0758	0.7F		1011	1259	0.7E		1057	1339	0.6E	
9946	1232	0.5E		1011	1259	0.7E		1009	1243	0.5E		1057	1339	0.6E		1538	1918	1.2F		1517	1904	1.0F		
1504	1849	1.0F		1538	1918	1.2F		1517	1904	1.0F		2300				2229				2229				
				2229				1517				2300				2300				2300				
TU	0524	0751	0.5F	M	0540	0818	0.7F	TU	0542	0815	0.5F	F	0556	0849	0.7F		1113	1359	0.6E		1158	1439	0.6E	
1031	1313	0.5E		1113	1359	0.5E		1101	1338	0.5E		1718	2037	0.8F		1635	2009	1.0F		1606	1947	0.9F		
1543	1930	1.0F		1635	2009	1.0F		1606	1947	0.9F		2344				2311				2311				
				2328				1606				2344				2344				2344				
12	0223	0.3E		27	0251	1.1E		12	0235	1.0E		27	0309	1.0E										
M	0611	0837	0.4F	TU	0629	0915	0.7F		0619	0858	0.5F	SA	0638	0940	0.8F		1218	1459	0.6E		1258	1539	0.5E	
1121	1401	0.4E		1218	1459	0.6E		1156	1435	0.5E		1628	2038	0.3F		1736	2103	0.9F		1736	2103	0.9F		
1628	2015	0.9F		1736	2103	0.9F		1704	2038	0.3F		2334				2334				2334				
				2334				1704				2334				2334				2334				
13	0309	0.9E		28	0017	0342	1.0E	13	0321	0.9E		29	0030	0357	0.9E									
TH	0655	0929	0.4F	F	0716	1011	0.7F	SA	0656	0945	0.6F	SU	0721	1034	0.3F		1223	1604	0.5E		1255	1535	0.5E	
1216	1456	0.4E		1223	1604	0.5E		1255	1535	0.5E		1307	2227	0.6F		1307	2227	0.6F		1307	2227	0.6F		
1722	2105	0.8F		1845	2204	0.8F		1811	2133	0.7F		1932	2227	0.6F										
14	0328	0355	0.9E	29	0108	0436	0.9E	14	0329	0404	0.9E	29	0117	0446	0.9E									
F	0718	1019	0.5F	SU	0803	1108	0.3F	SU	0732	1036	0.7F	M	0801	1123	0.3F		1128	1459	0.6E		1154	1744	0.5E	
1316	1555	0.4E		1429	1713	0.5E		1355	1639	0.5E		1454	1744	0.5E		1429	1713	0.5E		1454	1744	0.5E		
1826	2158	0.7F		1958	2306	0.6F		1927	2233	0.6F		2048	2336	0.5F		1940	2311	0.7F		1940	2311	0.7F		
15	0117	0443	0.8E	30	0200	0527	0.3E	15	0128	0453	0.8E	30	0206	0535	0.3E									
SA	0819	1110	0.6F	SU	0848	1201	0.8F	M	0811	1128	0.8F	TU	0844	1212	0.9F		1201</td							

SUN'S RISING AND SETTING AT NEW YORK (THE BATTERY)

74° W 40° 42' N

Add one hour for Daylight Saving Time, covering the summer months
FOR THE YEAR

1980

Day of Month	July		Aug.		Sept.		Oct.		Nov.		Dec.	
	Rises H. M.	Sets H. M.										
1	4:29	7:31	4:52	7:12	5:23	6:29	5:52	5:39	6:26	4:52	7:00	4:29
2	4:29	7:30	4:53	7:11	5:24	6:27	5:53	5:37	6:27	4:51	7:01	4:29
3	4:30	7:30	4:54	7:10	5:24	6:25	5:54	5:35	6:28	4:50	7:02	4:29
4	4:30	7:30	4:55	7:09	5:25	6:24	5:55	5:34	6:30	4:48	7:03	4:29
5	4:31	7:30	4:56	7:07	5:26	6:22	5:56	5:32	6:31	4:47	7:04	4:29
6	4:31	7:30	4:57	7:06	5:27	6:20	5:57	5:31	6:32	4:46	7:05	4:29
7	4:32	7:29	4:58	7:04	5:28	6:19	5:58	5:29	6:33	4:45	7:06	4:29
8	4:32	7:29	4:59	7:03	5:29	6:17	5:59	5:29	6:34	4:44	7:07	4:29
9	4:33	7:29	5:00	7:02	5:30	6:15	6:00	5:26	6:36	4:43	7:08	4:29
10	4:33	7:28	5:01	7:00	5:32	6:14	6:02	5:24	6:37	4:42	7:09	4:29
11	4:34	7:28	5:02	6:59	5:33	6:12	6:03	5:23	6:38	4:41	7:10	4:29
12	4:35	7:27	5:03	6:57	5:34	6:10	6:04	5:21	6:39	4:40	7:10	4:29
13	4:36	7:26	5:04	6:56	5:35	6:08	6:05	5:19	6:40	4:39	7:11	4:30
14	4:37	7:26	5:05	6:55	5:36	6:07	6:06	5:18	6:42	4:38	7:12	4:30
15	4:37	7:25	5:06	6:53	5:37	6:05	6:07	5:16	6:43	4:37	7:12	4:30
16	4:38	7:25	5:07	6:52	5:38	6:03	6:08	5:15	6:44	4:37	7:13	4:30
17	4:39	7:24	5:08	6:50	5:39	6:02	6:09	5:13	6:45	4:36	7:13	4:31
18	4:40	7:24	5:09	6:49	5:40	6:00	6:10	5:12	6:46	4:35	7:14	4:31
19	4:41	7:23	5:10	6:48	5:41	5:58	6:11	5:10	6:48	4:35	7:15	4:31
20	4:41	7:22	5:11	6:46	5:41	5:57	6:13	5:09	6:49	4:34	7:15	4:32
21	4:42	7:22	5:12	6:45	5:42	5:55	6:14	5:07	6:50	4:34	7:16	4:32
22	4:43	7:21	5:13	6:43	5:43	5:53	6:15	5:06	6:51	4:33	7:16	4:33
23	4:44	7:20	5:14	6:42	5:44	5:51	6:16	5:05	6:52	4:33	7:17	4:33
24	4:45	7:19	5:15	6:41	5:45	5:50	6:17	5:03	6:53	4:32	7:17	4:34
25	4:45	7:18	5:16	6:39	5:46	5:48	6:18	5:02	6:54	4:32	7:18	4:34
26	4:46	7:17	5:17	6:38	5:47	5:47	6:19	5:00	6:55	4:31	7:18	4:35
27	4:47	7:17	5:18	6:36	5:48	5:45	6:20	4:59	6:56	4:31	7:19	4:35
28	4:48	7:16	5:19	6:35	5:49	5:43	6:21	4:58	6:57	4:30	7:19	4:36
29	4:49	7:15	5:20	6:33	5:50	5:42	6:22	4:56	6:58	4:30	7:20	4:36
30	4:50	7:14	5:21	6:32	5:51	5:40	6:24	4:55	6:59	4:30	7:20	4:37
31	4:51	7:13	5:22	6:30			6:25	4:53			7:20	4:38

For correct SETTING of Sun any day of the year at places specified below, FOR FLAG USE, add or subtract from above table.

	July 15	Aug. 15	Sept. 15	Oct. 15	Nov. 15	Dec. 15
Hampton Rds., Va.	-1	+2	+7	+13	+18	+20
Oxford, Md.	+3	+5	+8	+11	+14	+15
Annapolis, Md.	+5	+7	+9	+12	+14	+15
Cape May, N. J.	-1	+1	+3	+6	+8	+9
Atlantic City	-2	0	+2	+4	+6	+6
Mannasquan, N. J.	-2	-1	0	+1	+2	+2
Port Jefferson, N. Y.	-3	-3	-4	-4	-5	-5
Bridgeport, Ct.	-1	-2	-3	-4	-4	-5
New Haven	-3	-3	-4	-5	-6	-7

METERS TO FEET

Meters	0	1	2	3	4	5	6	7	8	9
0	0.00	3.28	6.56	9.84	13.12	16.40	19.66	22.97	26.25	29.53
10	32.81	36.09	39.37	42.65	45.93	49.21	52.49	55.77	59.06	62.34
20	65.62	68.90	72.18	75.46	78.74	82.02	85.30	88.58	91.86	95.14
30	98.42	101.71	104.99	108.27	111.55	114.83	118.11	121.39	124.67	127.95
40	131.23	134.51	137.80	141.08	144.36	147.64	150.92	154.20	157.48	160.76
50	164.04	167.32	170.60	173.88	177.16	180.45	183.73	187.01	190.29	193.57
60	196.85	200.13	203.41	206.69	209.97	213.25	216.54	219.82	223.10	226.38
70	229.66	232.94	236.22	239.50	242.78	246.00	249.34	252.62	255.90	259.19
80	262.47	265.75	269.03	272.31	275.59	278.87	282.15	285.43	288.71	291.99
90	295.28	298.56	301.84	305.12	308.40	311.68	314.96	318.24	321.52	324.80

INSTRUCTIONS FOR U.S.C.G. RAYDIST OPERATOR

1. Await Master's permission.
2. Assemble equipment, install antenna on forward bridge centerline.
3. Power ON, check monitor for signal reception.
4. Set time into printer, coordinate with EA representative.
5. Set phase meters to standby.
6. Set Bay Bridge coordinates — RED: 520.00, GREEN: 1252.00
7. Set print interval to 10 seconds.
8. At Bay Bridge mark, initialize auto tracker.
9. Mandatory tape annotation.

INBOUND

- a. Bay Bridge mark
- b. Green range 294 degrees T (GREEN: 1206.60)
- c. Red range 250 degrees T (RED: 469.17)
- d. Abeam 1C
- e. Abeam 3C
- f. Abeam Baltimore Light
- g. Abeam 5C
- h. Abeam 7C
- i. Abeam 9C
- j. Abeam 13C
- k. Abeam 15C
- l. Range 7-foot knoll with Craighill Channel Leading Light
- m. Abeam 17C
- n. Abeam 19C
- o. Abeam 3B

OUTBOUND

- p. Abeam 4B

10. Check tape for complete annotation.
11. Insert tape in booklet envelope and initial.
12. Stow equipment.

